SEP 30 1932

MAINTENANCE ENGINEERING

In Plants, Mills, and Factories

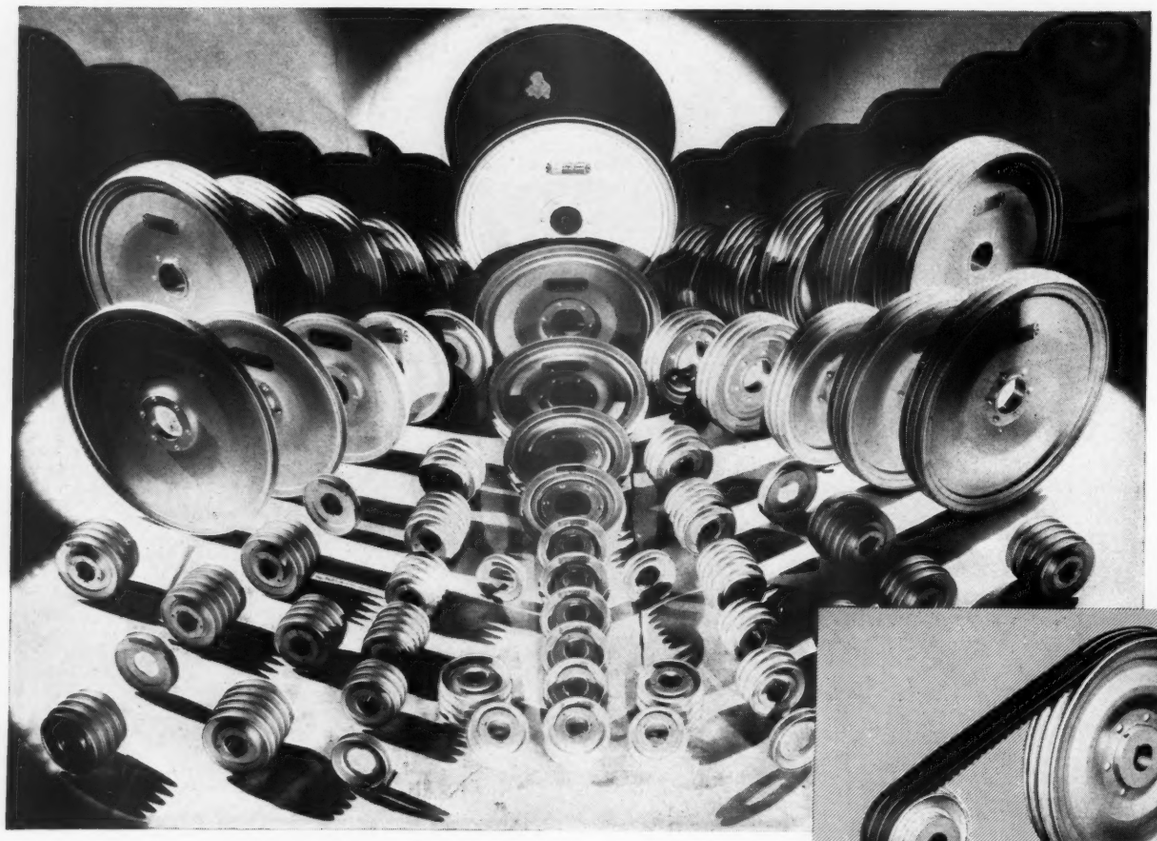
AS I analyze and study this situation I cannot help but feel that we have all been saturated with the strictest economies and curtailment of expenses. Therefore, the first step that is going to be made, of any consequence, is going to be the rehabilitation and opening up of our maintenance problems, throughout American industries.

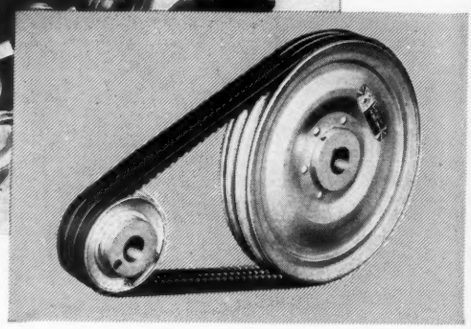
The Maintenance Engineers, both as to mechanical and electrical equipment, buildings, architectural and contracting work of every kind, are going to be the first professional men who will be in demand on any readjustment program at this time.

Therefore, in my judgment, everyone is going to be striving to get their house in order and rehabilitate all their facilities with the maximum economies which they still have in mind, from the reduction activities through which we have all just passed.—BY A WELL-KNOWN PLANT MANAGER.

25 cents a copy — McGraw-Hill Publishing Company, Inc.

OCTOBER
1932





DAY-STEEL PULLEYS
WITH DAYTON COG-BELTS

THIS NEW LOW PRICED V-BELT DRIVE IS NOW AVAILABLE IN A COMPLETE RANGE OF SIZES

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—*rigidly assembled* with a hub of unique design—providing *true running* and *accurate balance.*

—*finished* in high quality aluminum—providing *complete protection* and *outstanding appearance.*

NOW! 6 GROOVES
—made with 1 to 6 grooves
—for all ratings of 7½ h.p. and below—all speed ratios—all center distances.

Whether installed in your own plant or on machinery for resale, there's no other drive to equal the economies and the outstanding performance of Dayton Cog-Belt Drives with Day-Steel Pulleys.

It will pay you to find out how this new and different pulley saves money—how easy to select the proper drive without engineering or calculations—how immediate shipments can be made from stock.

We'll welcome your inquiries. Ask for Bulletin No. 110-A, which gives complete information.

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Dayton
COG-BELT DRIVES

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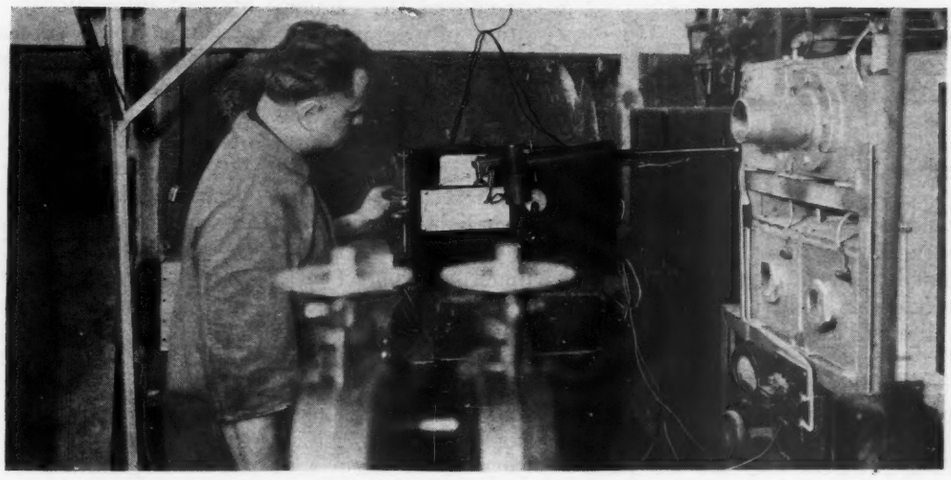

What Electron Tubes Are Doing

Counting parts, operating switches, controlling welding machines, other diverse activities, just part of the day's work

■

W. R. KING

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FROM THE maintenance engineer's point of view the most interesting thing about electron tubes is likely to be the answer to the question, "What can these tubes do better than more conventional apparatus, or at lower operating expense?" One of the classic examples of applications in which photoelectric equipment has been employed to advantage is its use in place of mechanical limit switches that have to withstand very severe service.

Such applications occur most frequently in steel mills, but many other plants are using mechanical limit switches to close or open electric circuits when the switches are "banged"—and that is just the word—by some heavy, rapidly moving piece of material in process. In some cases the switches are worn out in short order; in others the finished surface of the material is scratched or marred by contact with the switch arm; in still others the objects are so light in weight that they cannot operate limit switches.

In practically all such cases photoelectric relays may be employed to advantage. The common method is to pass a light beam across the path of the moving object so that the interception of the beam by the object will cause the relays to perform the necessary electrical control functions. The light beam itself cannot be worn out, no matter how many times it is interrupted. Since it offers no friction to the moving object it cannot mar the most highy polished surface, nor will it refuse to be interrupted by lightweight objects or flimsy materials. There are many places in industrial plants where such a system could be employed to advantage.

It is true, of course, that the lamp

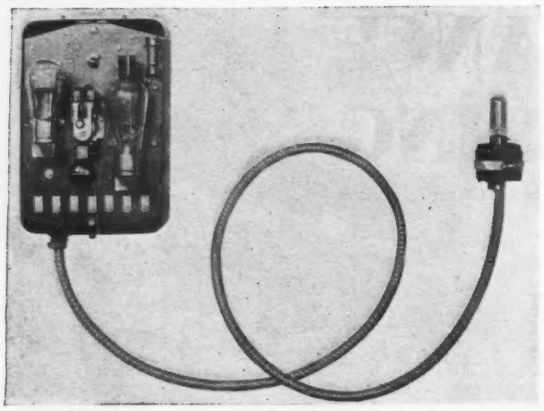


Fig. 1—Photoelectric relay with Thyratron tube. The photoelectric or light-sensitive tube is shown at the extreme right.

which projects the light beam will burn out, and that the electron tubes will in time reach the end of their useful life. Such matters can be controlled reasonably well, however, by a proper understanding and application of the equipment. High-intensity lamps, for example, when operated at their rated voltage have only a few hundred hours' life. If the voltage is decreased to 85 per cent of the rated value the life will be increased about ten-fold, whereas the light will be decreased less than half. Thus by using a lamp about twice the size that would be required if it were burned at full brilliancy, the same amount of light and ten times the life can be obtained by operating it at reduced voltage.

In the case of the electron tubes those that are recommended for industrial applications generally have been particularly designed for such service. They are more rugged and have a longer life than their predecessors, radio tubes, because such characteristics are essential in providing the continuity of service required of industrial equipment. Here again the design of the equipment in which the tubes are employed plays an important part in determining the actual life. Most industrial equipments employing electron tubes are designed to provide an average tube life of one year of continuous service. On the basis of the eight-hour day, three-hundred-day year this means an average tube life of three years.

Photoelectric relays employing Thyratron tubes in place of sensitive relays have been designed. One such device is shown in Fig. 1. A small contactor is mounted on the panel to make the equipment suitable for those applications which require such a device, but the tube shown may control directly loads up to ½ amp. Hence, solenoids or large contactors may be controlled from the phototube without any intervening electro-mechanical devices. Of course, a larger tube may be employed in the same manner for controlling loads in excess of the ½ amp. mentioned.

The speed of response of the device shown in Fig. 1 is the result of the elimination of one magnetic relay, and makes it well suited for counting objects by interception of a light beam. Accurate count may be secured with an interruption of the light beam lasting only one-twentieth second. With a like period between light interruptions, it is possible to count as high as 600 per minute without any contact-making devices or moving parts other than the magnetic counter which is energized directly by the tube.

Some applications, however, require even high speed of response. A typical example is in the control of paper cutting in registry with printed matter previously imprinted on the paper. The slipping, stretching, and shrinking of the paper necessitate some form of control to assure cutting in registry with the printed matter. Each imprint includes a small spot that passes before the phototube and reduces the light reflected into it from the surface of the paper. The resultant change in phototube current is amplified and applied to the grid circuit of two Thyratron tubes.

Attached to the rotary cutter knife is a rotary selector switch. This switch is also connected in the grid circuit of the two tubes and if the knife is in its proper position when the spot passes before the phototube neither of the two tubes passes current. If the knife is ahead of or behind its proper position when the spot passes the phototube, one or the other of the Thyratron tubes is almost instantaneously energized and operates the necessary control equipment to change the relative speeds of the paper feed rolls and the cutter knife.

Since the paper often travels as fast as 500 feet per minute and the spot is only a fraction of an inch long, it is apparent that the time allowable for energizing the tube circuit is only a few thousandths of a second. The tube can respond in this time, however, and continues to pass current until the proper control function is completed, when its circuit is opened automatically. The system which has been successfully applied in this partciular application is capable of responding to light impulses or interruptions as short as 50 millionths of a second.

A distinctly different use of photoelectric equipment has been made in its application to indicating devices, such as meters, gages, scales, etc., to close an electric circuit when the indicating device reaches a desired value. In such applications a lightweight vane is generally attached to the moving element of the instrument and arranged to intercept the light beam falling on a phototube when the moving element reaches the predetermined point. Since the neces-

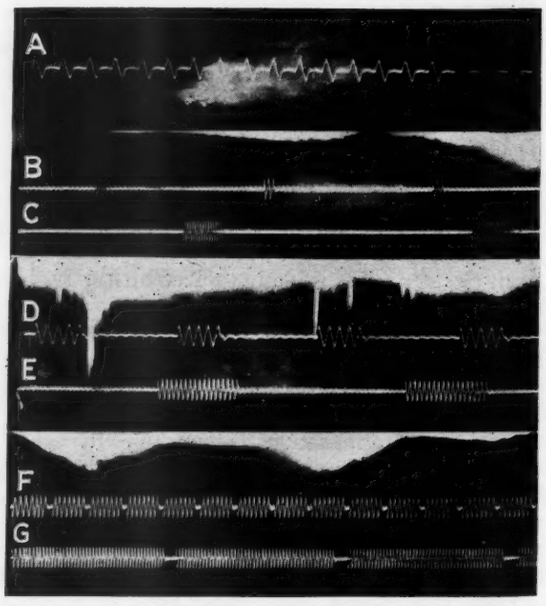


Fig. 2—What the oscillograph shows about tube control of resistance welding machines. Line *A* shows current on during 1 cycle and off 1 cycle; *B*, 2 cycles on, 34 cycles off; *C*, 15 cycles on, 95 cycles off; *D*, 4 cycles on, 10 cycles off; *E*, 17 cycles on, 36 cycles off; *F*, 7 cycles on, 1 cycle off; *G*, 47 cycles on, 4 cycles off.

sary light beam may be passed through a very small opening, the accuracy of the system is very good. And, of course, there are no delicate contacts to wear out. The accuracy of the instrument is in no way impaired, since the light beam offers no friction to the moving system.

Thyratron tube control is now being used on many resistance welding machines. Originally this type of control merely replaced the mechanical interrupters or magnetic contactors that controlled the flow of current to the welding transformer. These contactor devices had to make and break circuits carrying several hundred amperes and sometimes had to operate several hundred times a minute. The service was very severe and the contactors were a continual source of trouble and excessive maintenance expense.

The original tube system consisted of a pair of Thyratron tubes connected in the secondary circuit of a series transformer whose primary was connected in series with the welding transformer primary. When the tubes were conducting, the series transformer was virtually short-circuited and the primary impedance was reduced to a minimum, permitting maximum current to flow in the welding circuit. Conversely, when the tubes were not conducting the series transformer secondary was open-circuited and the primary impedance was high, thus permitting only a very small current to flow in the circuit.

The grids of the tubes were controlled by a small switch connected in the grid circuit; the switch was operated by a cam in much the same manner as the switch which had previously controlled the magnetic contactor. This system operated successfully and permitted operation at higher speed (more welds per minute) than the mechanical interrupter or magnetic contactor. There was no heavy circuit interrupting device to wear out and the small switch in the grid circuit could be made to stand the high-speed service because of the light weight of its moving parts.

As the work progressed, however, it was found that at the higher speeds, when the welding current was on for only a few cycles, the accuracy was not high. One "on" period would be four cycles, for example, and the next would be five cycles—25 per cent more. When the contact tips wore, the inaccuracies were greater than ever. These same inaccuracies had been present in the mechanical interrupters and magnetic contactors, but since the "on" periods were always longer, the percentage error was not so great.

It was apparent that a timing device was needed which had no parts to wear out and which would be synchronous with the alternating-current voltage. Such a system has now been developed and a number of installations made. Timing is accomplished by the use of a condenser and resistor arrangement in which a Thyratron tube is caused to pass current at regular intervals of a certain number of cycles. This arrangement controls two other tubes so that it is possible to adjust the ratio of "on" to "off". These tubes in turn control the power tubes in the same manner that the small switch was previously used to control them.

The system is very flexible. By turning a small rheostat the total time cycle, "on" plus "off", may be varied from two cycles to a few seconds. By means of another rheostat the ratio of "on" to "off" time may be adjusted over the full range in steps of one cycle. Fig. 2 shows oscillograms of the welding current. It will be noted that for each adjustment the "on" and "off" periods are exactly the same. In Fig. 3 a welded piece is shown, illustrating the types of welds that were made with the same machine, merely by adjusting the control rheostats on the tube timer panel. Shown in Fig. 4 is the complete panel mounting the power tubes, timer tubes, control rheostats, and other accessories.

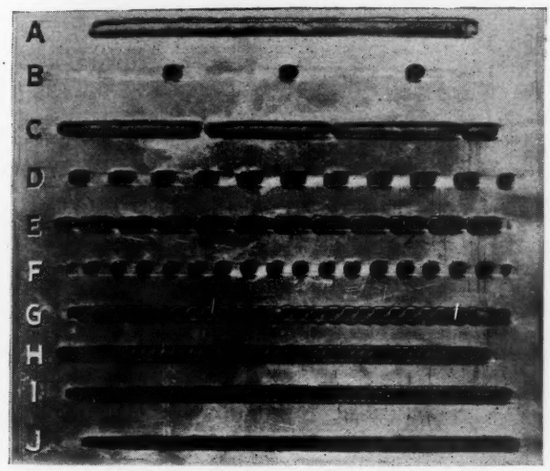


Fig. 3—Types of welds made with an intermittent line welder using tube control and operating at a speed of about 7 feet per minute. *A* represents 21 spots per inch; *B*, long off period, short on period; *C*, short off period, long on period; *D* and *E* intermediate speed and ratio; *F*, 1 2/3 spots per inch; *G*, 3 spots per inch; *H*, 4½ spots per inch; *I*, 6 spots per inch; *J*, 14 spots per inch.

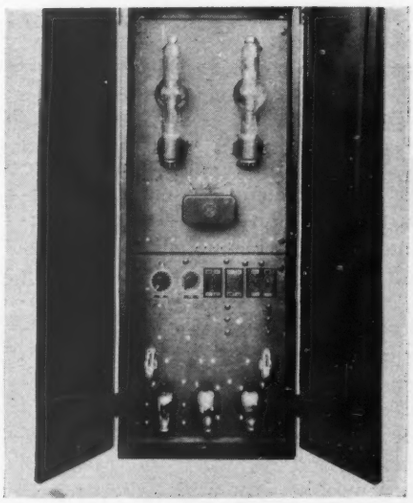


Fig. 4—Thyratron tube control panel for resistance welder.

The electron tube offers many possibilities in electrical control systems. Some problems may be solved by the proper application of standard apparatus; for example, photoelectric relays. Others may require the design of equipment, but may use a well-known system. Again the design of a complete new system to meet the particular needs may be required. Thyratron control for resistance welders is an example of a system that was completely developed to meet the particular requirements of the application.

■

NEXT MONTH look for a fact-full article on how a number of plants have reduced power bills and improved operation by raising the power factor. It's full of money-saving suggestions.

We Have Lowered Costs, Eliminated Failures, by Proper Lifting Chain Maintenance

BENJAMIN HANTMAN

Ass't. Supt., Light, Heat and Electrical Equipment
Maintenance Department
Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

INSPECTION and maintenance of sling chains deserve more attention than they receive oftentimes, because chain failures may result in accidents to persons, breaking of material and equipment, interruptions in production schedules, lowering of morale, and other costly items. Too frequently this subject is given the attention it really deserves only after a serious or fatal accident occurs; and interest even then may be temporary.

Our company has always recognized its responsibility in keeping hoisting equipment in safe condition and early developed a comprehensive plan for so doing, the main points being:

1. Use of chains made from the best grade of wrought iron.
2. Employment of a full-time inspector.
3. Keeping a card file on all chains.
4. Posting "Tables of Safe Loads" where required.
5. Handling own repair work.
6. Doing own "normalizing" at 1,700 deg. Fahrenheit.

Recently the management appointed a committee to review the subject of chain maintenance and submit recommendations. Industrial plants in the Pittsburgh district were visited and a lack of uniformity in methods was found. Different grades of chain material and various tables of safe loads were used. Also, the users of chains did not agree on the methods of heating and cooling, annealing temperatures, type of furnace, and intervals between annealing. In one plant which has a good annealing furnace the vision of the attendant instead of a pyrometer is depended upon to determine when the proper temperature has been reached.

In practically all of the plants chains are repaired by the blacksmiths, although most blacksmiths are not competent chain makers. Where the men were qualified through experience, adequate forging facilities were lacking.

Some plants subjected new chains to chemical analysis; others had their inspectors watch the new chains being proof-tested at the suppliers' plant.

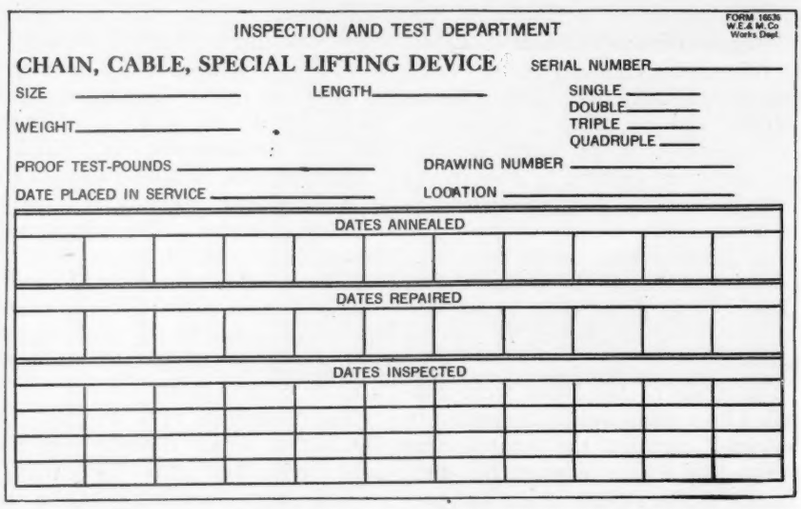
No plant had any means of determining whether a chain is safe after repairing or annealing, other than visual inspection upon which little reliance may be placed.

The committee concluded that for proper forging, annealing and testing, special equipment would be required, costing approximately $65,000. Since this equipment would not be used sufficiently to warrant such an investment it was recommended that all repair work be given to a reliable chain manufacturer having suitable equipment and personnel.

After careful study of heat treating, it was decided to replace normalizing at high temperatures with annealing at the lower temperatures.

The committee further recommended that:

1. All chains be serially numbered and a card index kept.
2. An experienced man be delegated to inspect all chains; however, this should not relieve the department foremen of responsibility for the use and abuse of chains.
3. All chains be inspected at least once a month or oftener, depending upon their use.
4. Only the best grade of wrought iron be used in manufacturing or repairing chains.
5. "Tables of Safe Loads" be posted where chains are in use.
6. The diameter of the chain stock be stamped on the end link, and the "Table of Safe Loads" be consulted before making a lift.
7. Sling chains be annealed as frequently as the service justifies; however, it should be done at least annually.
8. Crane chains be annealed at least every two years except in cases


INSPECTION AND TEST DEPARTMENT

FORM 1653S W.E.&M. Co. Works Dept.

CHAIN, CABLE, SPECIAL LIFTING DEVICE SERIAL NUMBER

SIZE LENGTH SINGLE DOUBLE TRIPLE QUADRUPLE

WEIGHT

PROOF TEST-POUNDS DRAWING NUMBER

DATE PLACED IN SERVICE LOCATION

DATES ANNEALED

DATES REPAIRED

DATES INSPECTED

The life history of lifting chains and cables can be seen at a glance from this card index.

of severe usage, when it should be done at least annually.

9. Annealing be done in a furnace designed for that purpose. The chains should be spread out so that they will be heated uniformly. Temperature to be controlled by the aid of pyrometers placed at each end and at the middle of the charge, and kept between 1,350 and 1,375 deg. Fahrenheit. Time of annealing:

Size of Chain	Time in Hours
¼ in. to ½ in.	¼
Over ½ in. to 1 in.	¾
Over 1 in. to 1⅝ in.	1
Over 1⅝ in.	2

At the expiration of the time specified the chains should be removed from the furnace and spread out in a dry, protected location so that they can cool freely and uniformly in air.

10. Each chain be proof-tested to 1.9 times its working load after it has been repaired or annealed.

11. The allowable working load be ⅕ of the breaking load, thus giving a factor of safety of 5.

12. When the diameters of any chain links are reduced by wear so that the factor of safety has been cut from 5 to 3, these links should be replaced by new ones. The following table shows the original diameter with a factor of safety of 5, and the reduced diameter with a factor of safety of 3.

Original Diameter, Inches	Reduced Diameter, Inches
⅜	19/64
½	⅜
⅝	15/32
¾	37/64
⅞	43/64
1	49/64
1⅛	7/8
1¼	31/32
1⅜	1 1/16
1½	1 5/32
1¾	1 11/32
2	1 17/32

13. Proper storage facilities be provided for chains not in use.

14. Hooks that are seriously deformed be scrapped.

15. All repairing or annealing of chains be done by a reliable chain manufacturer having the proper facilities, and be in accordance with recommendation 9.

16. A certificate be furnished by the chain manufacturer for each chain showing what work has been performed.

In view of the many uses to which sling chains are put, scheduled servicing can not be considered adequate. A sling chain in a foundry may require servicing at least once a month, whereas a similar chain in a machine shop may not require any servicing for a year. Frequently it is necessary to service a chain after one lift in a foundry, if it has been abused. However, all chains should be inspected at least once a month except in foundries, where inspection should be made at least once a week. The foreman or the floorman of a department should call the inspector during the interval between scheduled inspections if a chain has been subjected to unusual loading, or if it does not appear to be safe.

It is necessary that a competent man be delegated as inspector, empowered to designate when a chain is to be taken out of service for repairs and annealing. By a competent man is meant one with average intelligence, ability to cooperate with others, and who has had experience or special training. Some chain manu-

On the inspection and testing floor. Ninety-foot lengths of chain can be tested in the trough by clamping one end to a stationary post and fastening the other end to a hydraulic piston which puts a predetermined load on the chain. It is then inspected link by link for failure or deformity.

facturers, at no expense to the chain user, will train men for this work.

His duties should include the examination of chains for:

1. *Stretch*—All new chains should be marked with a prick punch on the side of the link so that the distance between marks is 3 ft. when the chain hangs freely. On short chains this marking may be eliminated and the length measured from the bearing point of the ring to the bearing point of the hook. The length should be recorded on the card index. When a chain shows a stretch of 1 in. in 3 ft. it should be annealed. If the stretch is greater than this amount and the links bind, that portion of the chain should be scrapped.

2. *Opening of Welds*—Any link that begins to open at the weld should be replaced by a new one.

3. *Wear Between Links*—Any link that is reduced in diameter, as covered in recommendation 12, should be replaced.

4. *Gouge Marks* — Any link that is gouged or cut so that the diameter is reduced to that shown in recommendation 12 should be replaced.

5. *Work Hardening* — A chain that is work-hardened should be annealed. In this condition the surfaces of the links are bright and have small indentations resembling peen marks.

6. *Cracks* — Any link showing cracks across the metal in addition to the appearance of work-hardening should be replaced.

7. *Bent Links*—Any link that is bent should be replaced.

8. *Hook Spread* — Any hook that is opened up to 115 per cent of its original dimension should be reset to the original; if opened beyond that point it should be replaced.

9. *Bent Hooks* — Any hook that is bent at the neck should be replaced.

10. *Rings*—Any ring that is worn or gouged so that the diameter is reduced below 77 per cent of the original dimension, or that has cracks across the metal in addition to the appearance of work-hardening, should be replaced.

The inspector's kit of tools should include a 50-ft. steel tape, a 6-ft. rule, a 6-in. steel scale, calipers, prickpunch, stencils, hammer, and a magnifying glass.

It may be mentioned that the only salvage from discarded chain material is the market value of scrap wrought iron.

In instructions to floormen the following rules (although not original) were included in the committee's recommendations:

(*a*) Do not make lifts beyond the safe carrying capacity of the slings as shown in the "Table of Safe Loads."

(*b*) Do not twist or tie knots in slings to shorten them; only slings of proper length should be used.

(*c*) Do not place bolts, nails, or pieces of iron between the links of a chain to shorten it.

(*d*) Do not splice broken chains by inserting a bolt between two links with the head of the bolt and the nut sustaining the load, or by passing one link through another and inserting a bolt or nail to hold it.

(*e*) Use wood or other packing on sharp corners of the load in order to protect the chains.

(*f*) Do not submit any slings to sudden jerks when making a lift.

(*g*) Do not drag chains over floors, castings, or other material that

SAFE LOAD IN POUNDS
FOR
CHAIN WIRE ROPE AND MANILA ROPE SLINGS

LOADS SPECIFIED MUST NOT BE EXCEEDED

OCT. 24, 1929

DIA.	CHAIN P.D. SPEC 1591				WIRE ROPE P.D. SPEC. 3105				MANILA ROPE P.D. SPEC. 3106			
	USED STRAIGHT	USED AT 60° ANGLE	USED AT 45° ANGLE	USED AT 30° ANGLE	USED STRAIGHT	USED AT 60° ANGLE	USED AT 45° ANGLE	USED AT 30° ANGLE	USED STRAIGHT	USED AT 60° ANGLE	USED AT 45° ANGLE	USED AT 30° ANGLE
$\frac{3}{8}$	1800	1550	1250	900	2050	1750	1450	1000	200	170	140	100
$\frac{1}{2}$	3000	2600	2100	1500	3700	3200	2600	1850	340	290	240	170
$\frac{5}{8}$	4600	4000	3250	2300	5600	4850	3950	2800	560	480	400	280
$\frac{3}{4}$	6750	5850	4800	3400	8050	7000	5700	4000	690	600	490	350
$\frac{7}{8}$	9350	8100	6600	4670	10800	9350	7650	5400	980	850	690	490
1	12400	10700	8750	6200	14000	12100	9900	7000	1150	1000	810	580
$1\frac{1}{8}$	15600	13500	11000	7800	17600	15200	12400	8800	1550	1350	1100	780
$1\frac{1}{4}$	19200	16600	13600	9600	22000	19000	15500	11000	1750	1500	1250	880
$1\frac{3}{8}$	23000	19900	16300	11500	27200	23600	19200	13600	2240	1950	1600	1100
$1\frac{1}{2}$	27200	23600	19200	13600	32000	27700	22600	16000	2450	2100	1750	1200
$1\frac{3}{4}$	35000	30300	24700	17500	43200	37400	30500	21600	3550	3100	2500	1800
2	44400	38500	31400	22200	52000	45000	36800	26000	4200	3650	2950	2100
$2\frac{1}{2}$	69600	60300	49200	34800	85600	75100	60500	42800	6100	5300	4300	3050
3									8550	7400	6050	4300

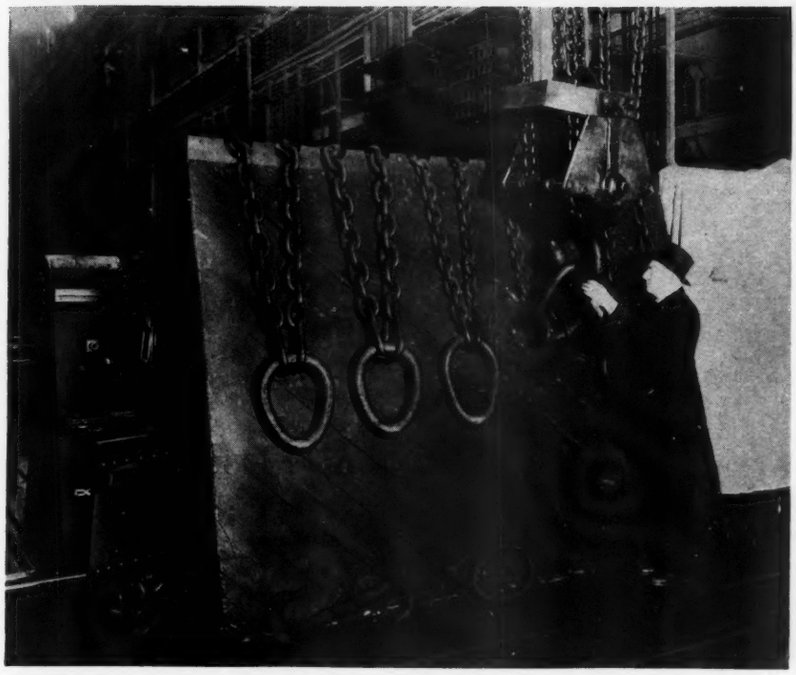
THE SAFE LOADS SPECIFIED IN THE TABLE ARE FOR EACH SINGLE CHAIN, WIRE OR MANILA ROPE WHEN USED DOUBLE, OR IN ANY OTHER MULTIPLE, THE LOAD MAY BE INCREASED PROPORTIONATELY. IF, FOR EXAMPLE, THE SLING HAS 3 LEGS, THE LOAD MAY BE 3 TIMES THE LOAD SPECIFIED ABOVE STUB HOOKS TO BE USED FOR LIFTING APPARATUS, WHICH IS PROVIDED WITH HOLES FOR THAT PURPOSE.

APPROXIMATE WEIGHT OF ONE SQUARE FOOT OF BOILER PLATE

THICKNESS IN INCHES	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$
WEIGHT IN POUNDS	$2\frac{1}{2}$	5	$7\frac{1}{2}$	10	$12\frac{1}{2}$	15	$17\frac{1}{2}$	20	25	30	35	40	45	50
THICKNESS IN INCHES	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5
WEIGHT IN POUNDS	55	60	65	70	75	80	90	100	110	120	140	160	180	200

APPROXIMATE WEIGHT OF ONE FOOT OF ROUND AND SQUARE STEEL BAR

SIZE IN INCHES	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ROUND (IN POUNDS)	$2\frac{3}{4}$	11	24	43	67	96	130	170	220	265	325	385	455	525
SQUARE (IN POUNDS)	$3\frac{1}{2}$	14	31	55	85	123	167	220	275	340	410	490	575	670
SIZE IN INCHES	15	16	17	18	19	20	21	22	23	24	25	26	27	28
ROUND (IN POUNDS)	600	685	720	865	965	1070	1180	1290	1410	1540	1670	1820	1940	2080
SQUARE (IN POUNDS)	765	870	980	1100	1230	1360	1500	1645	1800	1960	2125	2300	2470	2660



A rack that provides a safe and convenient place for storing sling chains.

may possibly have an abrasive action.

(*h*) Do not use slings at acute angles. (See Table of Safe Loads.)

(*i*) Do not lift with the point of a hook.

(*j*) When lifting portable machine tools from bedplates, work from machine tools, or any other apparatus or material, make sure that all bolts or other clamping devices have been removed.

As a result of these recommendations we have not only reduced the maintenance cost of chains, but with approximately 3,000 chains in service have had no chain failures during the past three years, except in several cases of deliberate overloading.

■ ■

Industrial Unit Heaters

Comment

INTERESTING comment has reached us concerning the second article of the series, "Industrial Unit Heaters," published in the August issue.

A manufacturer of draw-through, suspended type heaters (The L. J. Wing Manufacturing Company) comments upon the author's statement that there is objection on the part of some engineers to placing the motor in the hot air stream. He points out that in his design (which we illustrated as Fig. 13 in the article) the use of a shield above the motor, and distribution through multiple outlets, surmount the objection. He is quite right, and this fact should have been mentioned, instead of relying entirely upon the illustration to make it clear.

The meaning of another statement has been questioned. The author makes the statement that condensate may be as much as 5 pounds per hour. Since he is not writing only to heating specialists he would have made his meaning clear had he said, "5 pounds per hour per square foot of radiating surface."

A third statement is questioned, i.e., reference to variations in "resistance" to the heated air as it is delivered by the heater. Actually there was not meant the implication that in service unit heaters meet with fluctuations in resistance. Practically, resistance is constant. The statements made were, in fact, digressions from strict consideration of unit heaters into the realm of abstract design—possibly a fault, in that it might lead to confusion on the part of some of our readers.

The editors attach so much importance to the series of articles on industrial unit heaters that they welcome the comment on these points as constructive additions to the articles themselves.

■

When the Central Station Was Born

OPENING of Pearl Street station, the first commercial generating plant, 50 years ago, represented not only the culmination of several years of intense activity by Thomas A. Edison and his helpers: it was the end of one era of civilized life and the beginning of another.

When his lamp had been perfected Edison laid plans for the large-scale generation and distribution of current. Formation in 1880 of the Edison Electric Illuminating Company, capitalized at $1,000,000, was followed in about a year by the granting of a franchise, purchase of the Pearl Street site, and beginning of the work of laying the mains or conductors.

These consisted of iron pipes 20 ft. long containing two half-round copper rods held apart first by cardboard and, later, by wrappings of small rope. A mixture of asphalt and linseed oil was used to insulate them.

The area served by the first installation was about 1 mile square. Direct current was generated and distributed at 110 volts.

In the basement of the station were four boilers rated at 240 hp. each. The six generators on the second floor were direct connected to engines of 125-hp. rating, and because of their size—each generator with its engine weighed 30 tons—they were termed Jumbos.

At exactly 3 o'clock in the afternoon of September 4, 1882, the main switch of Jumbo No. 9 was closed, and central station service became a reality as 400 16-candlepower lamps began to glow on the premises of the company's 59 customers. Service was given free for several months; then on January 17, 1883, the first bill for current was sent out.

All except one of the Jumbos in the Pearl Street station were destroyed by fire on January 2, 1890. The survivor, No. 9, is now in the Henry Ford Museum of American Industries, at Dearborn, Michigan.

Dual-Voltage Connections for Induction Motors

Series and parallel connections two-phase, four to ten poles

A. C. ROE

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IN THE preceding article, in the July issue, the basic principles of the schematic-line diagram were outlined and data given for two-pole, two-phase diagrams. Factors common to four-, six-, eight- and ten-pole, two-phase, schematic-line, dual-voltage diagrams will now be discussed.

The series arrangement of the pole-phase groups for two-phase windings, 2 to 24 poles inclusive, is shown in Table I. The A- and B-phase groups are placed at right angles to each other in order to provide the schematic arrangement; the groups are also arranged with the tops and bottoms in proper order, and the arrow indicates the proper polarity. The lines at one side of the group, marked *2, 4, 6,* etc., indicate the groups included in any one number of poles and help in constructing a new diagram, as will be shown later.

To illustrate the procedure a series (HV) and two-parallel (LV) two-phase, four-pole, schematic diagram will be constructed. For layout purposes cross-section paper having $\frac{1}{4}$-in. squares should be used; it can be used under thin, plain white paper, using the squares and lines as layout guide lines.

From Table I it will be seen that each phase contains four groups, and for a dual-voltage connection this means two groups per section. The first step is to indicate by dots and number the groups as in Fig. 1*A*, taking the arrangement from Table I. In Fig. 1*B* the polarity arrows have been applied as indicated in the table. A study of Table I reveals that the connection of leads *L5, L6, L7,* and *L8* is governed by two rules:

Rule 1. When the number of groups per section is odd as 1, 3, 5, the *L5* and *L6* leads connect to the bottom of the last group of the first section and the *L7* and *L8* leads to the bottom of the first group of the second section.

Rule 2. With an even number of groups per section, the *L5* and *L6* leads connect to the tops of the last group in the first section and the *L7* and *L8* leads to the tops of the first group in the second section.

In Fig. *1C,* the leads have been attached in accordance with these rules; the top (*T*) and bottom (*B*) of each group have been marked and the jumpers indicated by the dotted lines connecting the groups together. Fig *1D* shows the leads marked according to the preceding rules, and in Fig. *1E* the finished diagram is shown. In numbering the jumpers, start on A-phase group *1* and proceed down the A phase, as Fig. *1E* shows.

Table II in the preceding article gives the line lead connections for all of the diagrams shown in this article.

Comparison of Fig. *1E* with the standard two-phase, four-pole line diagram in Fig. *2* will show how simple and clear the schematic-line diagram is—earier to construct and to understand.

Parallel-Connection Schematic-Line Diagrams

The parallel type of connections as applied to the schematic type of dia-

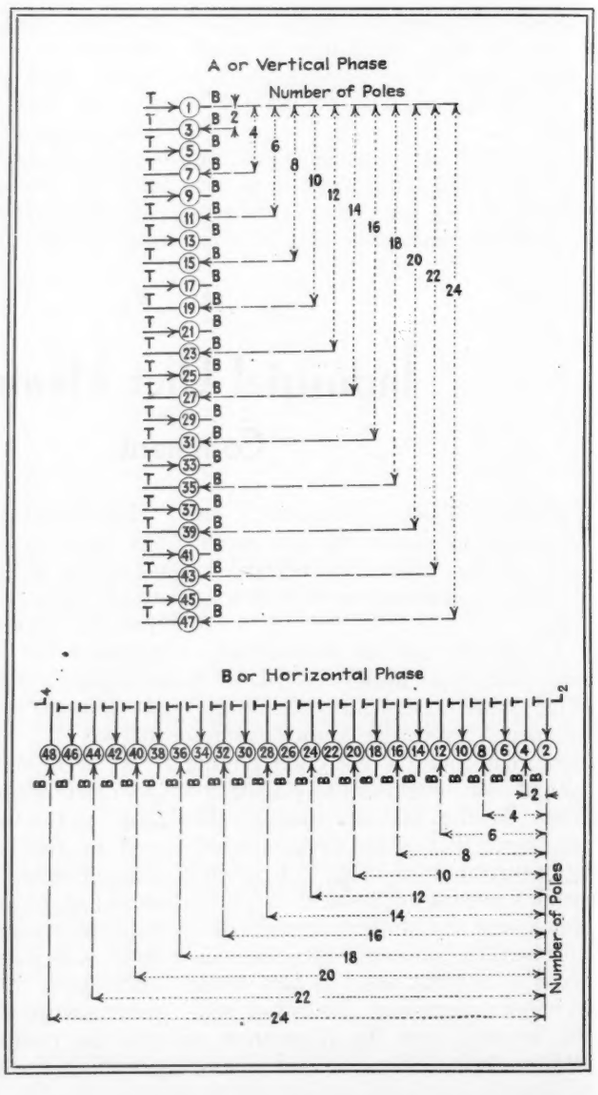


Table 1 — Phase groups listed in proper order for two-phase, lap windings, 2 to 24 poles, inclusive. The A- and B-phase groups are placed at right angles to each other in order to provide the schematic arrangement.

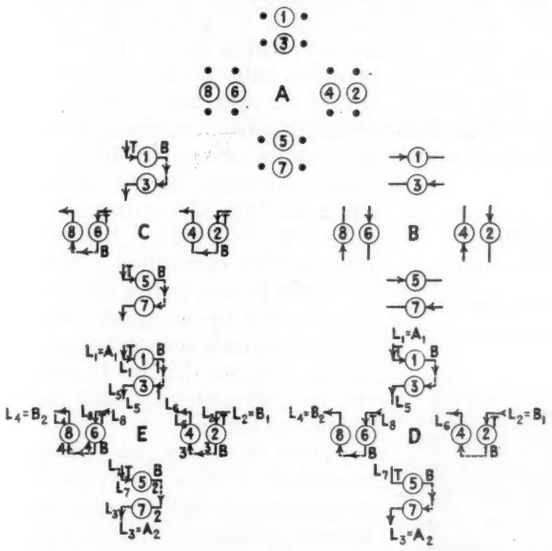


Fig. 1—Steps in the construction of a two-phase, four-pole, series and two-parallel diagram. (Table II in the preceding article shows the line lead connections for all diagrams in this article.)

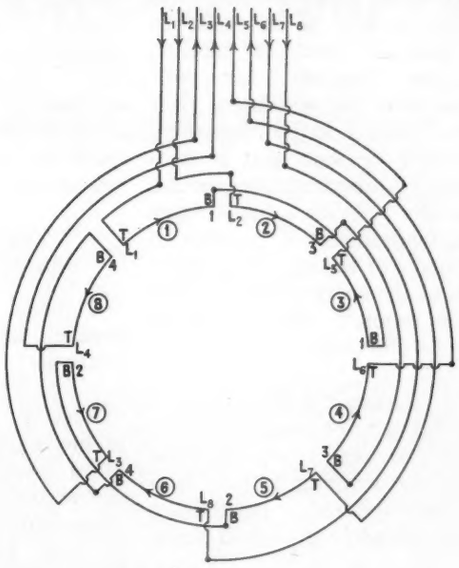


Fig. 2—Standard two-phase, four-pole, series and two-parallel diagram.

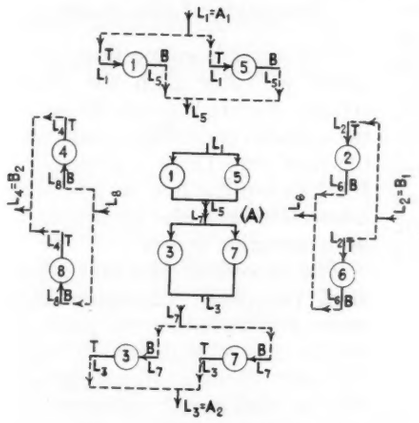


Fig. 3 — Two-phase, four-pole, two-parallel and four-parallel diagram.

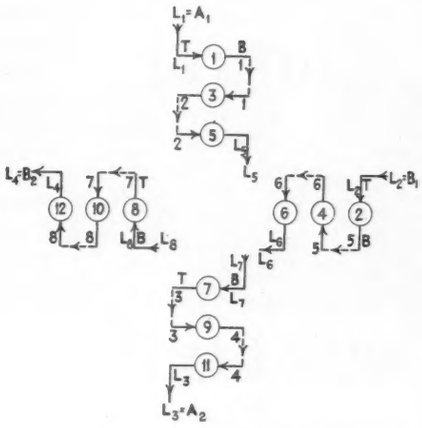


Fig. 4 — Two-phase, six-pole, series and two-parallel diagram.

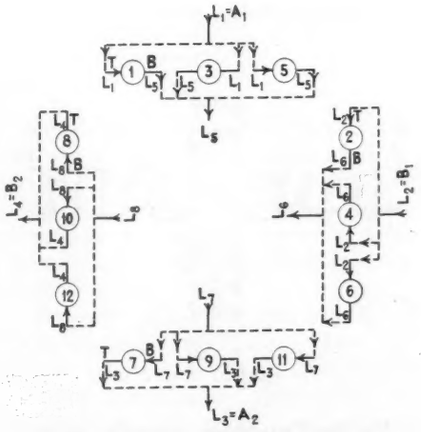


Fig. 5—Two-phase, six-pole, three-parallel and six-parallel diagram.

Fig. 6—Two-phase, eight-pole, series and two-parallel diagram.

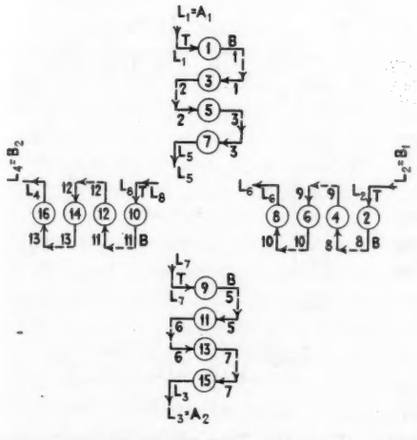
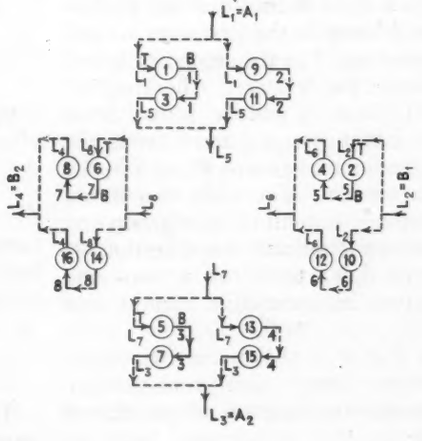


Fig. 7—Two-phase, eight-pole, two-parallel and four-parallel diagram.



gram has some rules that are not common to the series type previously discussed, and it will be in order to consider how to construct parallel, schematic-line diagrams for two-phase, four-pole lap windings. Referring to Table I in the preceding article it will be seen that a two-parallel and a four-parallel connection are possible. With dual-voltage schematic diagrams it is possible to take advantage of the equalizing characteristics of the short jumper or top-to-top connection.* The following rule must be observed:

Rule 3. To arrange the groups in each parallel leg for equalization, it is necessary to have groups that are located on the winding 180, 120, or 90 deg. apart plotted opposite each other in the parallel leg of each phase.

Referring to Table I it will be seen that groups *1* and *5, 3* and *7* in the A

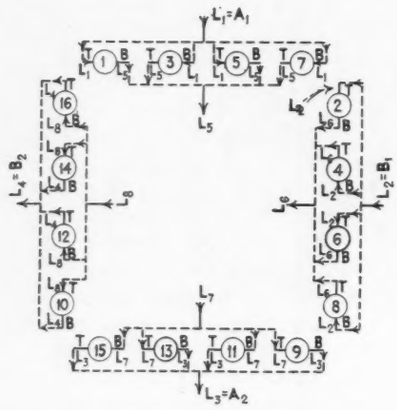


Fig. 8—Two-phase, eight-pole, four-parallel and eight-parallel diagram.

phase are 180 deg. apart; likewise, groups *2* and *6, 4* and *8* in the B phase are opposite. Therefore groups *1* and *3* should be placed in one leg and groups *5* and *7* in the other leg, groups *1* and *5* being in the first section, and groups *3* and *7* in the second or lower section of the A phase. Checking for the B phase it will be found from Table I that groups *2* and *6* are in the first section and groups *4* and *8* in the lower section. The table also shows the top and bottom of each group and the arrows indicate the direction of current flow; therefore a two- and four-parallel connection can be laid out.

In Fig. 3 is shown the two-phase, four-pole, two- and four-parallel, schematic-line diagram as constructed from Table I, and the rule given above. Fig. 3*A* shows that the two-parallel connection gives maximum equalization, because when leads *L5* and *L7* are joined together they form an equalizer connection. The advantages offered by the dual-voltage diagrams for equalization are used to the full extent in this series.

Two-Phase, Six-Pole Schematic-Line Diagrams

Figure 4 shows the series and two-parallel diagram and illustrates the next rule:

Rule 4. The two rows of groups in line on any two-phase series diagram form concentric squares with the arrows of the first outer circle comprising the first and last groups of each phase, pointing clockwise. The next circle points counter-clockwise and the third circle, clockwise.

This feature holds true for all series, two-phase schematic-line diagrams and is a reliable check on any connection. In Fig. 5 is shown the two-phase, six-pole, three- and six-parallel, schematic-line diagram with the groups arranged for maximum equalization. Note that even in this parallel connection the first and last groups, *1* and *2*, and *11* and *12*, form, when considered alone, a square with

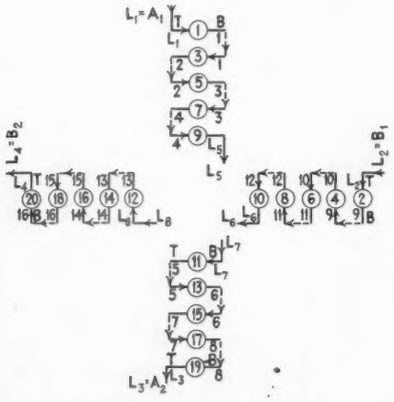


Fig. 9—Two-phase, ten-pole, series and two-parallel diagram.

all arrows pointing clockwise, conforming to Rule 13 and indicating that Table I can be used to check the polarity of all groups.

Two-Phase, Eight-Pole Schematic-Line Diagrams

Table I in the previous article indicated three possible connections on the eight-pole range, and Fig. 6 shows the series and two-parallel connections. Note the concentric-circle arrangement of groups and direction arrows; that is, groups *1, 2, 15* and *16* form the outer circle, groups *3, 4, 13,* and *14* the next, and so on, the arrows on the groups all pointing in the same direction in one circle and in the opposite direction in the next inner circle, as Rule 13 requires.

In Fig. *7* is shown the two- and four-parallel connection. Note that the lower groups in this diagram have been moved up alongside the upper groups and each section opened in the middle to form the two halves. The two-parallel connection also has some equalizing action.

Figure 8 shows the groups arranged in a four- and eight-parallel connection. It will be seen that consecutive groups, as *1, 3, 5, 7,* are arranged in the sections of each phase, and the high-voltage connection (four-parallel) has equalizer action.

Two-Phase, Ten-Pole Schematic-Line Diagrams

Two possible connections are indicated by Table I in the preceding article. Figure 9 shows the series and two-parallel connection made up from the data that Table I gives. In Fig. 10 is shown the five- and ten-parallel connection with the groups arranged in consecutive order.

The preceding data and rules covering two-phase connection diagrams up to and including ten poles should enable one to understand, construct, and use schematic-line diagrams. It will be well worth while to lay out and construct one or more diagrams in order to obtain a thorough knowledge of the principles involved.

In the next article, to appear in an early issue, the three-phase, star type of schematic-line diagram will be discussed.

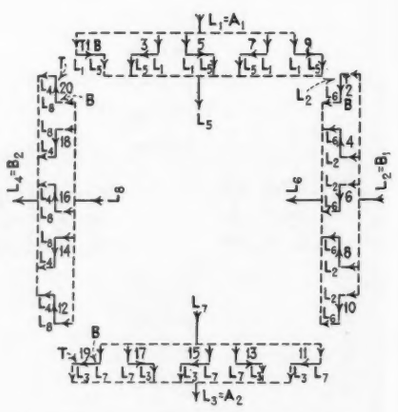


Fig. 10—Two-phase, ten-pole, five-parallel and ten-parallel diagram.

*See "Rewinding and Connecting A.C. Motors," by Braymer and Roe.

INDIVIDUAL AND GROUP DRIVES

Investment and Operating Cost Data

ROBERT DRAKE

Mechanical and Electrical Engineer, Chicago, Ill.

Total annual costs of group and individual drives with tables showing comparative cost data for six characteristic types of industrial plants and conclusions for entire series of five articles.

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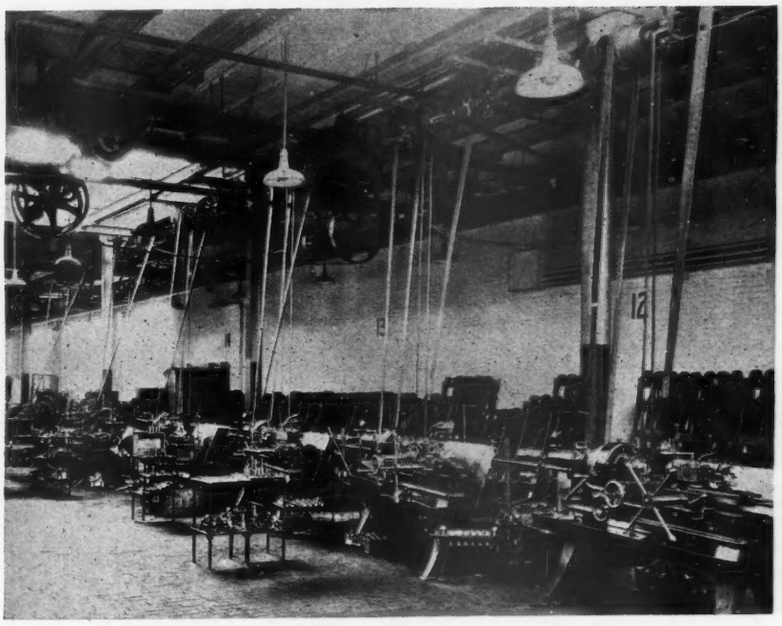


Turret lathes and screw machines frequently are set at an angle to give clearance for bar work. Such an arrangement is not precluded by group drive.

ESTIMATES of the comparative installation costs of group and individual drives were presented in the preceding article. Annual operating costs for these types of drives will be considered in this article, which is the last of the series.

The desirability of group drive and individual drive in any given factory depends upon manufacturing considerations and comparative costs. Comparison of the relative advantages and disadvantages from a production standpoint is difficult. No simple tabulation of figures preceded by dollar signs is ordinarily possible.

It is useless to attempt to assume any "average case" from which general conclusions may be drawn. The same characteristics that may be advantageous in one application may be serious drawbacks in another. In the first article of this series, in the June issue, certain aspects of this question were considered in some detail.

There is no intention on my part to deprecate the importance of manufacturing and production considerations in making a decision as to which type of drive to employ. I wish merely to emphasize the difficulty of the task and the necessity for considering each case in the light of its individual conditions.

As to comparative costs, on the other hand, a consideration of intelligently selected cases leads to fairly general conclusions and points the way for similar individual comparisons where conditions are so far from typical that general conclusions seem inapplicable.

In some cases first cost may be of commanding importance; for example, in the case of an experimental or pilot plant in a new industry where progress in the art or rapid growth may be expected to lead to rapid obsolescence. More frequently, perhaps, new construction or extensions are to be made under conditions that lead to a very high price for capital, or great difficulty in obtaining it at any price.

Ordinarily, however, in the case of a going concern with good credit, comparative annual cost is of more importance than first cost, and is given primary consideration. By comparative annual costs I do not mean operating costs alone. The wages of the capital invested must be included as well as the wages of the operating force. So there must be included in the comparisons fixed charges, interest, depreciation and obsolescence, insurance, and taxes on investment.

In such a comparison most companies figure interest on investment at 6 per cent, and insurance and taxes at $1\frac{1}{2}$ to $2\frac{1}{2}$ per cent. It is more difficult to generalize as to a fair figure for depreciation and obsolescence. The useful life of motors, when well maintained and rewound when necessary, ordinarily exceeds twenty years. Most of the a.c. motors of one excellent line sold forty years ago are still in service and the users, in many cases, wish that they could obtain more of them.

In a group-driven plant motors may generally be reapplied throughout their useful life. In an individually driven plant the life of many

TABLE IV

TOTAL ANNUAL COSTS FOR POWER AND MAINTENANCE OF ELECTRICAL AND MECHANICAL POWER DRIVE EQUIPMENT

	Abnormally Stable Two-and Three-Shift Plant				Average Manufacturing Industry				Feast or Famine Industry			
	Group		*Individual*		*Group*		*Individual*		*Group*		*Individual*	
	A Many Small Drives	B Medium Drives	A Many Small Drives	B Medium Drives	C Many Small Drives	D Medium Drives	C Many Small Drives	D Medium Drives	E Many Small Drives	F Medium Drives	E Many Small Drives	F Medium Drives
Cost of purchased electric power per year, from Table I	$93,900	$80,060	$110,300	$92,200	$67,450	$54,700	$87,200	$70,300	$56,300	$42,850	$69,050	$58,400
Fixed charges — Interest, depreciation, taxes, insurance at 15% on investment in mechanical and electrical installation	55,600	29,700	105,600	50,350	58,300	31,600	114,000	56,400	59,260	31,800	128,450	63,800
Supervision, substation operator and storekeeper (often same man), clerical and miscellaneous similar expense	11,000	11,000	13,000	13,000	9,000	9,000	10,000	10,000	8,000	8,000	9,000	9,000
Mechanical power transmission equipment — repairs, inspection, maintenance per year — Labor*	20,000	16,000	10,200	7,000	13,000	9,000	7,500	5,500	11,000	8,000	7,000	5,000
Material	18,700	8,700	5,200	2,400	12,000	6,000	3,600	1,700	10,000	5,000	3,000	1,300
Cost of electrical maintenance and inspection (includes cables, etc.)*	6,000	3,900	12,000	7,500	4,300	2,900	10,000	5,800	3,900	2,500	9,000	5,000
Cost of repairs to motors, starters, wiring and mains (not incl. rewinding)*	1,000	500	2,000	1,500	600	300	1,100	800	400	200	800	600
Cost of rewinding motors*	1,000	500	10,000	3,500	500	240	6,000	2,000	350	175	4,000	1,500
Yearly cost of moving motors to keep up power factor	1,600	1,000	.....	2,500	1,600	1,000	.....	2,500	3,500	2,000	.....	500
Total annual cost of power	$208,800	$151,360	$268,300	$179,950	$166,750	$114,740	$239,400	$155,000	$152,710	$100,525	$230,300	$145,100

No overhead expense is included in above labor items except that foreman's time included in item 3 may be a burden item in many plants. The comparison does not include any costs chargeable to electric furnaces or lighting (except that some of the expense in item 3 could properly be prorated to lighting and electric furnaces).

*Supervision (foreman, etc.) not included. This charge is included in item 3.

motors will depend upon the period of usefulness of the machines which they drive. When the driven machine becomes obsolete, which in the case of machine tools happens in five years or less in many industries, the motor may be removed and used again, if the machine is to be scrapped, or it may be sold with the machine, at a fraction of the first cost. The latter is, of course, the universal practice with special, built-in motors; it is usual with direct-coupled units and common with motors otherwise connected. In such cases the motor and starter cost, the cost of installing on the machine, and the cost of couplings, pulleys, idlers, belts, chains, and the like, is largely lost, because the second-hand value of obsolete equipment is frequently nominal.

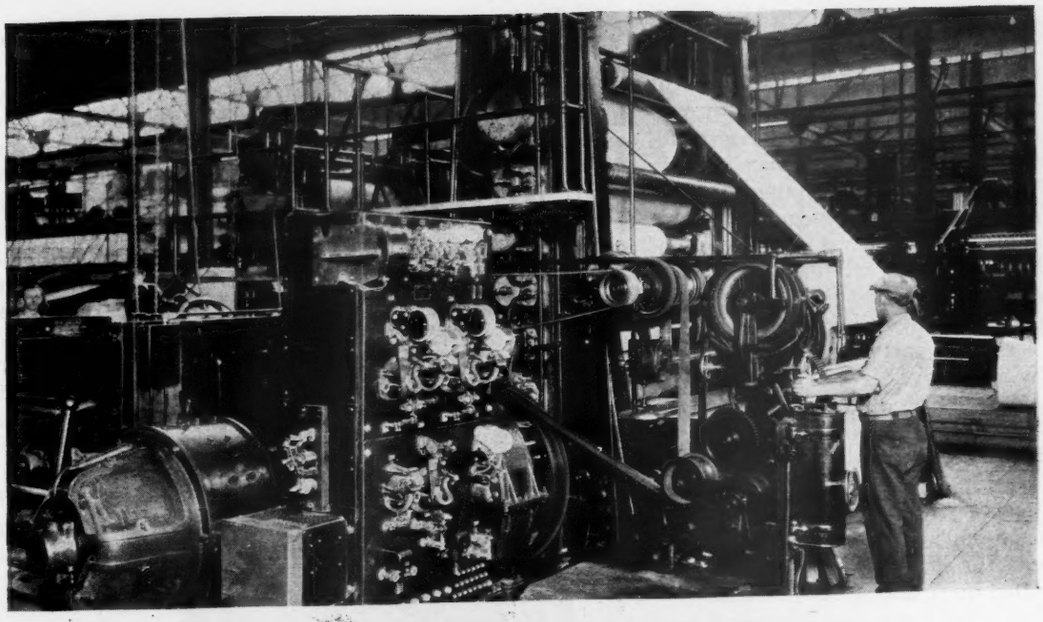
When an individually driven machine is moved or disposed of, or when a group-drive motor is replaced by one of considerably greater capacity, almost all the money spent for the original wiring is lost. Similarly, when a group-drive motor is moved or an individually driven machine is reapplied for another purpose requiring a different motor size, the motor installation cost is lost.

It is clear that obsolescence and not durability controls the life of the investment in such items. This is true to a large extent in the case of control equipment. Many excellent a.c. motors built forty years ago are still in service. How many use the original controllers? So great has been the advance in the performance, durability, and safety of controllers that few have been continued in operation for more than twenty years. Room for further improvement in the overload protective performance of such equipment is so great that the same conditions may well prevail for some time to come.

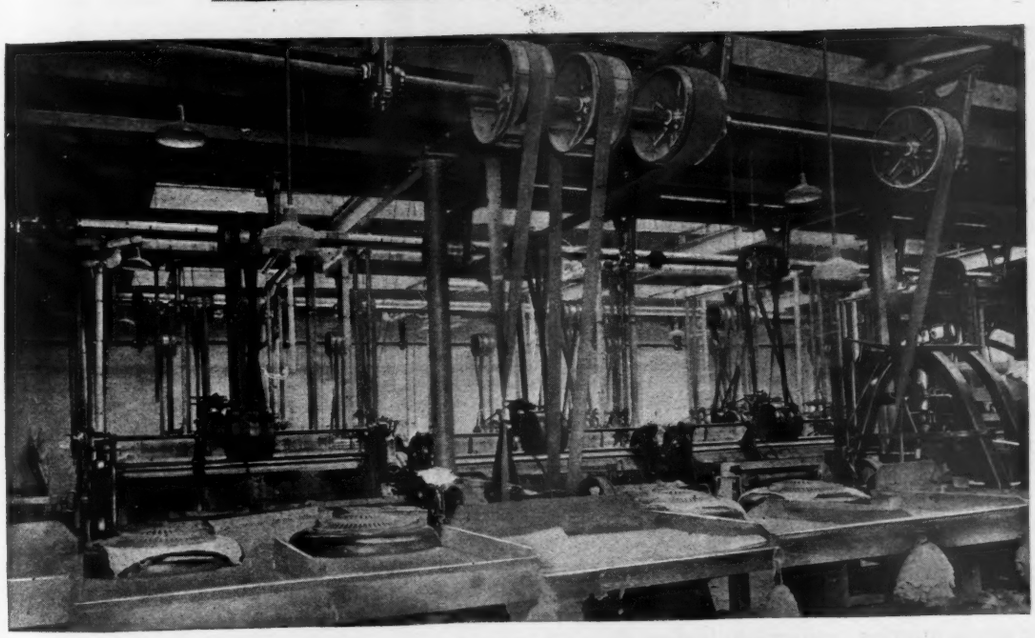
The life of belting, speed reducers, and some other items is frequently on the order of five or ten years, rather than twenty years.

The durability life of shafting is high, and it is ordinarily reused with very little extra expense over the cost of installation of new material. The life of hangers, pulleys, and such items is long and in a large plant opportunity to reuse them frequently occurs. When group drives are rearranged or moved there is a partial or complete loss of the original installation cost.

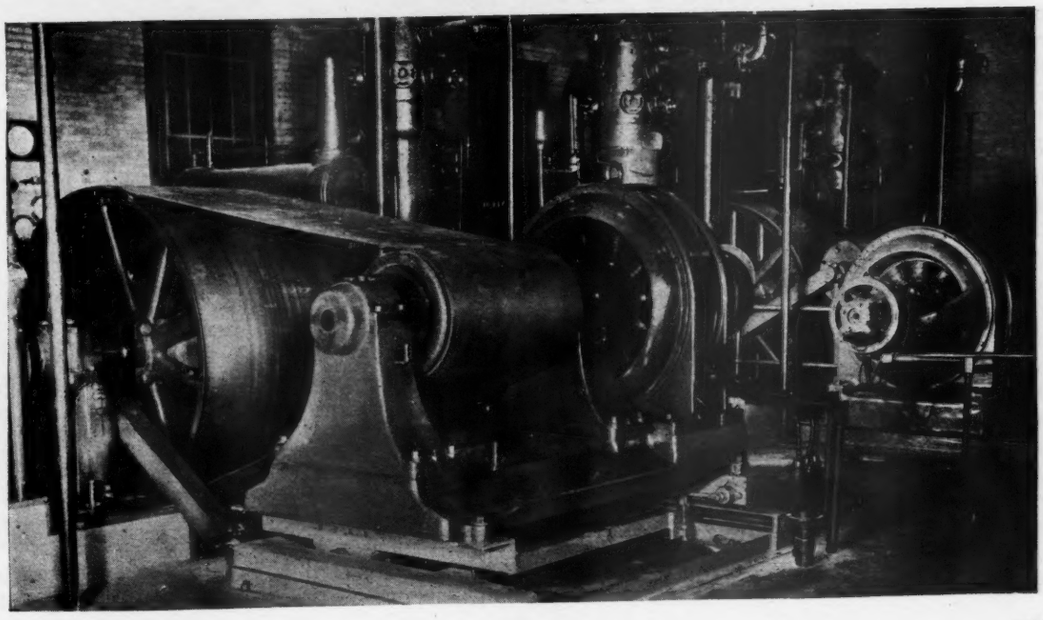
It may be said, therefore, that the depreciation and obsolescence charge will vary with the industry. In the spinning room of a textile mill where



Direct-connected, motor - driven super - calender stack. Three voltages to provide speed regulation. Difficult to group drive.



In this laundry all of the machinery is group driven except the extractors, the circular tops of which can be seen back of the sorting bench.



The compressor, again — individually driven. 400-hp. synchronous motors. Pivoted motor base. 38-in. triple belt. 7 ft. 2-in. center distance.

machinery is rarely scrapped, replaced, or moved, the overall charge for depreciation and obsolescence of the power drive equipment may well be as low as 5 per cent. In an automobile plant where radical yearly change in production equipment is the rule, and serviceable equipment that represents the highest present state of the art is frequently displaced simply because it is not suited to the "new model," a much higher rate is necessary, particularly for individual drive.

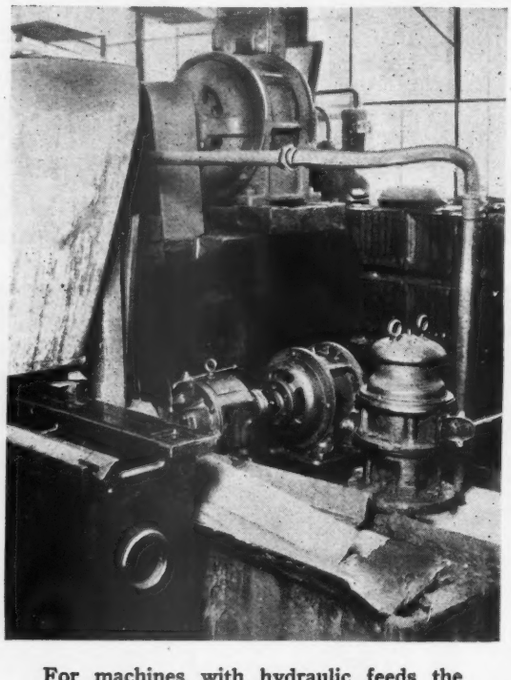
A study of several industries from this standpoint indicates that the proper over-all allowance for depreciation and obsolescence covering power equipment seldom falls below 5 per cent for either group or individual drive and seldom exceeds 6 per cent for group drive or 9 per cent for individual drive. For our comparison, which is detailed in Table IV, a general figure of 7 per cent will be used which leads to a total figure for interest, depreciation, obsolescence, insurance, and taxes of 15 per cent—a value that is very commonly used.

Some comments on certain items in this table of comparisons of annual costs will be in order.

The proportion of enclosed, fan-cooled, ball-bearing motors that will require rewinding each year in individual-drive service is still a matter of surmise. All types of motors show lower maintenance costs when new than later. This new type of motor has been applied in considerable numbers for less than five years, and the early designs were much inferior to those at present available. Winding failures from the entrance of metal particles, oil, or coolant have been eliminated.

Failures from cast-iron dust in the coils have been practically eliminated in the motors recently produced by most manufacturers, and in plants that dip and bake completed rewinding jobs. For some years this has been largely true of open motors also. Roast-outs should be increased by the higher average operating temperature of the enclosed motors, particularly in plants where a determined effort is made to reduce overmotoring. In the present comparison I have estimated that the total number of these motors rewound will lie between one-fourth and one-sixth of the number rewound in a similar individually driven plant equipped with open motors. The failures may well be still less for the first few years.

The synchronous condenser capacity required has been based on the assumption of a power contract requiring a minimum of 85 per cent power factor. Contracts of various power companies differ in this requirement; in some cases the same company has different requirements according to the size of the load. The figure given above is a fair average. As a matter of fact our hypothetical plants would have a power factor somewhat higher than 85 per cent because of the lighting load. In a plant that has a considerable electric furnace load decidedly less correction than assumed would be necessary.



For machines with hydraulic feeds the individual drive is appropriate. In this instance a hydraulic transmission operates the grinding machine table.

In our cost estimates sufficient corrective equipment has been included to give 85 per cent power factor under the worst conditions likely to be encountered through a period of years. In an individually driven plant this condition comes, of course, with maximum plant activity. For a group-driven plant the greatest corrective effect is required when the plant is very slack, with most of the departments running, but undermanned. In any case, all of the plants except *A* and *B* will have during most years more corrective equipment available than is needed.

In cases where purchased power contracts contain bonus clauses for a power factor above the required minimum, the excess corrective capacity can be employed very profitably. In such cases the power costs tabulated can be reduced somewhat.

Likewise, the cost of power to plants *E* and *F* may be reduced if a monthly demand contract is available, instead of an annual demand contract.

The demand charge of $18 a kilowatt-year based on maximum demand, and the average energy charges assumed, are believed to be a fair average of those available in the medium-sized manufacturing centers in the eastern and central states. There are large cities in which decidedly lower rates are in effect and, of course, smaller manufacturing cities in which rates are higher. Any ordinary change in these rates will make only a small change in the relative cost of the two types of drive.

In comparing the tabulated average rate per kilowatt-hour for an existing plant, it is necessary to keep in mind the fact that these figures apply only to the power portion of the plant load. Ordinarily the lighting and power loads are billed together, but in a single-shift plant the lighting load is a short-hour load. Its demand charge raises materially the average rate for the plant. This increase is less marked in a two- or three-shift plant.

Before attempting to generalize from the preceding analysis and tabulations I shall summarize the limiting conditions.

It is unusual to find a plant where a careful study of the economics of the situation as well as manufacturing and production considerations point to an installation either completely group driven or completely individually driven. After eliminating those departments or portions of departments where one or the other type of drive offers definite and considerable advantages from a manufacturing standpoint, there remains a considerable portion of the plant where one method will give just about as good results as another, if both are planned with equal intelligence.

It is in the choice of drives for these portions of the plant that economic considerations should be most carefully weighed. To this great middle ground the following conclusions apply.

This whole analysis has been based on engineering of a rather high order,

both in the original planning of the layout, and in the following years. If the layout is planned from a distant "main office" and no effort is made when operation starts or from time to time thereafter, to replace underloaded motors and do other necessary things, the annual costs will be decidedly increased for both types of drive. Comparative costs should, however, be affected but little, assuming equally inadequate attention in all cases. The assumptions as to performance on which this analysis is based compare with the best-planned and best-operated plants of their respective types in this country.

The usual American manufacturing plant operates a considerable night shift in busy seasons, or "good" years. In the depths of a depression it operates short-time with a reduced force. Through a period of years it averages somewhat less than single-shift operation at capacity output. For such a plant the total annual costs for individual drive are about one-third higher than for group drive, and somewhat more if the individual motors average only 1 or 2 hp. in size.

The first cost of all power equipment, including electrical and mechanical transmission items, will be almost twice as great for the individual-drive layout as for group drive. To be exact, the cost will be approximately 80 per cent more when the average size of individual motors is 5 hp. or thereabouts; if the average individual motor size is 1 or 2 hp. the excess cost will be closer to 95 per cent.

For the familiar "feast or famine" industry—the plant that works night and day in some departments, has "no orders" in others and almost shuts down entirely in a depression year or in the dull season—the total annual cost will amount to about 50 per cent more for individual drive than for group drive. It will be a trifle more than that if the individual motors average only 1 or 2 hp. in size, and somewhat less for larger motors. The first cost of the whole power layout, including the mechanical transmission and other items described previously, will be from 2 to 2.2 times as great for individual drive as for group drive; the larger figure applies when the motors are small, say 1 to 2 hp. The lower figure will hold true for an industry in which 4- to 10-hp. motors, on the average, are required.

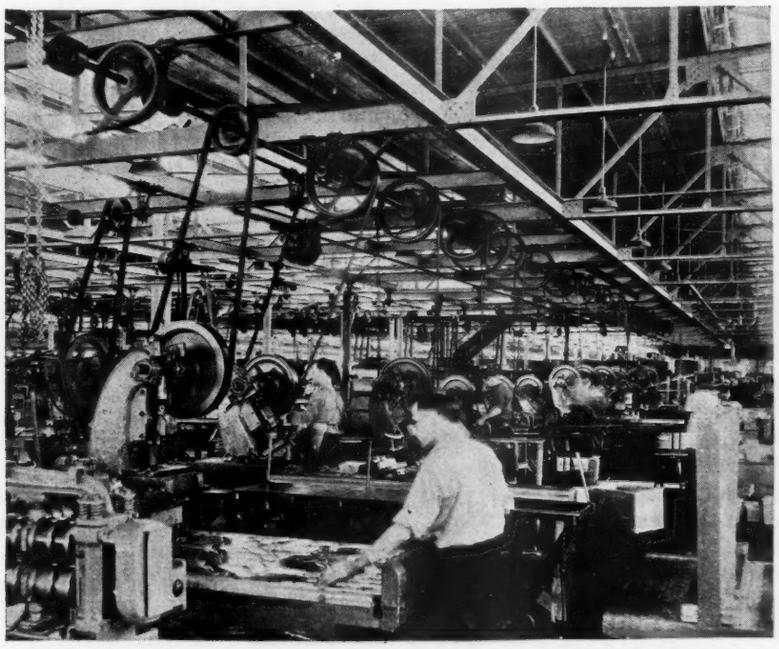
For a plant that averages two shifts except for single-shift operation in a dull season of three or four months, with three shifts in boom years and one shift in depression years, the total annual costs for individual drive will be about 25 per cent greater than for group drive. The costs will be a trifle more if the individual-drive motors average 1 or 2 hp. and a trifle less if they average 5 or 10 hp. The initial investment in electric power and mechanical transmission equipment, including power factor correction equipment, switchboards, distribution cables, and all, will average about 80 per cent greater for individual drive than for group drive. It will be 10 per cent less for the larger-sized motors mentioned above, and 10 per cent more when the average size is 1 or 2 hp. Such plants are uncommon.

In the case of a plant that works three shifts all year long, in good years and bad, in which most machines work continuously on an identical product and for considerable periods of years, where special tool equipment allows the continuous productive operation of most machines without delays for loading and unloading, the total annual cost of group and individual drives, fixed charges included, will be about the same. Group drive may have a slight advantage where the power required per machine is small, and individual drive may have the advantage where the power required per machine is large. In the middle ground it is a stand-off. The first cost, however, will be about twice as great for the individual-drive layout as for the group drive. Such a plant is so uncommon that this comparison has not been included in the tabulations.

There are several other conclusions that may be drawn from the tables in this and the preceding article which are worth mentioning. To my mind the most suggestive is the fact that in the group-driven plants the total cost of all electrical items installed amounts to only one-half to one-third the cost of the mechanical transmission items.

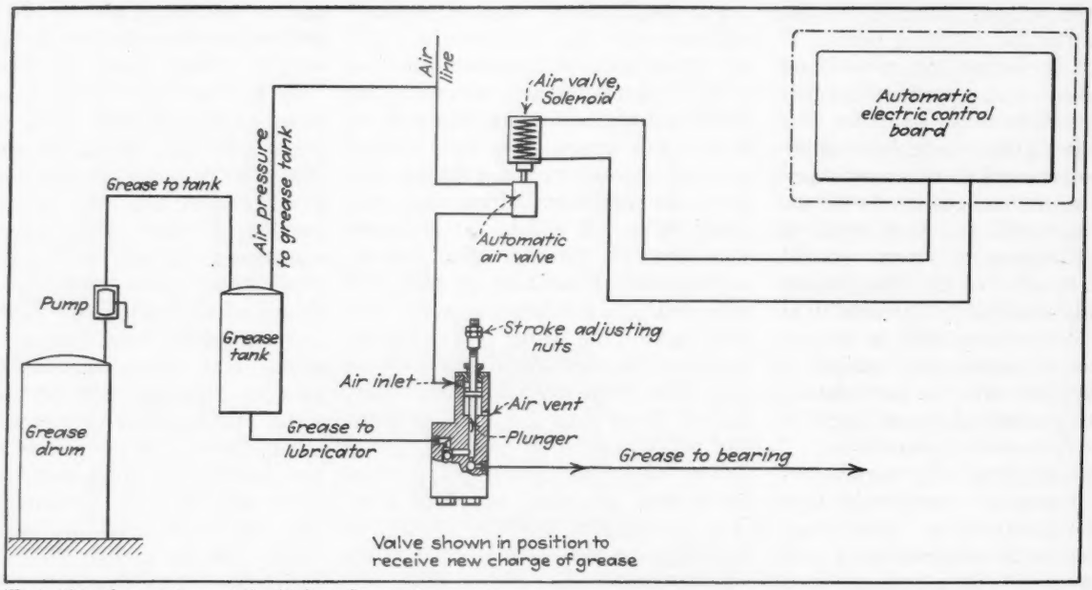
Seemingly little thought has been given to the possibilities of improving such equipment and at the same time lowering its cost. For many applications the use of group shafts operating at motor speeds, or at least at speeds decidedly higher than met in present practice, offers an opportunity for a considerable saving in first cost without any increase in group losses; in fact, in some cases group losses may be decreased. The design of such groups for minimum losses will require somewhat more thought than the design of a slow-speed group shaft, following present practice. Even the necessity for this thought would, however, disappear as soon as the newer design settled down to a generally accepted standard of practice. All the necessary elements have been available on the market for years. Nothing is needed that is special or untried.*

Any advance that would make possible an improved countershaft or substitute for a countershaft, including ball or roller bearings, would make a still greater saving.



Large installation of machines engaged on relatively light operations. Group drive is economical, sufficiently flexible.

**Maintenance Engineering*, page 18, January, 1932.



Illustrations by courtesy of the Hodson Corporation

Fig. 84—Electrically controlled pressure lubricating system.

LUBRICATING SYSTEMS

High Pressure

FRED H. LOW
Mechanical Engineer

Fourteenth and concluding article

INADVERTENTLY omitted from discussion under its proper heading in one of the first three parts of this series was a high-pressure lubricating system worthy of description because of its ability to handle plastic heavy-body greases, its automatic operation, and its flexibility.

The system is operated by air at a pressure of 80 to 100 lb. per sq.in. and is electrically controlled. It is adaptable to lubricants ranging from light cup greases to the heavy-body greases employed to lubricate the roll necks of blooming mills. In operation, a measured amount of grease is supplied under pressure to each bearing in the system at a predetermined interval. The amount of grease supplied through any outlet at one time may be varied from 0 to 0.3 oz., and the lubricating interval for any battery of four outlets may be adjusted to any value between 6 sec. and 1 hr. The equipment is designed for grease pressures up to 2,000 lb. per sq.in. A number of types of greases may be supplied in one system.

Four principal parts comprise the system: A grease tank, an automatic lubricator, a solenoid-operated air valve, and an automatic electric control unit. The relation of these parts with the necessary piping and wiring is shown in Fig. 84. Pipe ½ or ¾ in. in size is used for the grease.

The grease is pumped into the grease tank from a drum. When ready to operate, the compressed air, which acts against a cylinder within the tank, is turned on, exerting a constant pressure on the grease in the tank and in the lines leading to the lubricators.

In Fig. 85 are indicated the design and principle of operation of the lubricator. Each unit provides lubrication for four bearing outlets. The grease piston is reduced in area as compared with the air piston by an amount sufficient to give the required grease pressure. The length of stroke may be varied as desired by adjustment of the length of the piston rods accomplished by manipulation of the nut and locknut shown. In the position illustrated the piston has almost completed its stroke, and grease is being forced into the distribution line under high pressure. It will be noted that the high grease pressure acts on top of the spring-type ball valve at the right and therefore opens it, allowing the grease to escape into the distribution line. At the same time the high pressure acts against the low supply pressure on the lower side of the automatic spring valve at the left,

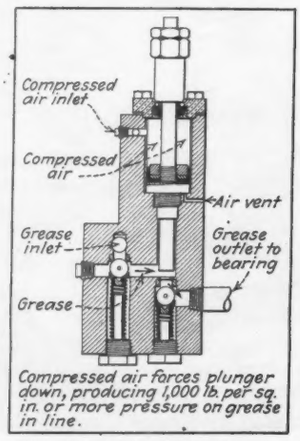

Compressed air inlet
Compressed air
Air vent
Grease inlet
Grease outlet to bearing
Grease
Compressed air forces plunger down, producing 1,000 lb. per sq. in. or more pressure on grease in line.

Fig. 85—Principle of operation of the lubricator.

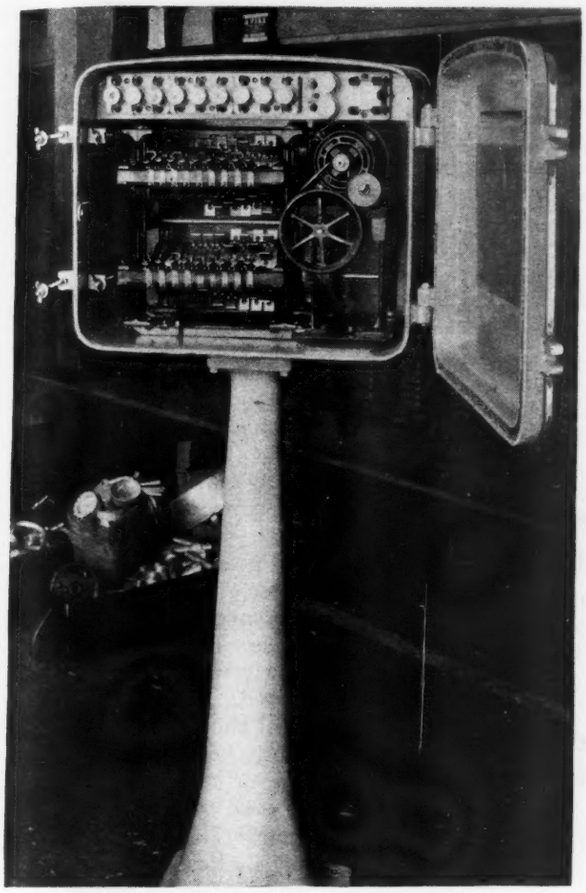


Fig. 86—Automatic electric control unit.

thereby sealing it and preventing flow-back of the grease into the supply line. Conversely, when the air pressure is removed from the cylinder, the valve at the left opens under the pressure of the grease supply, and the right-hand valve closes because the spring is considerably stronger than the supply pressure.

The automatic electric control unit, as shown in Fig. 86, consists of a small electric motor, a speed reducer, and two sets of electrical controls. Each set consists of a revolving cylinder containing about eight or ten contact units. By a suitable drive arrangement, each cylinder may be set to make one revolution in any desired time up to 24 hr. It can be understood readily that, by spacing the contacts properly around the peripheries of the cylinders, any desired lubrication interval from 0 sec. to 24 hr. can be obtained for each of sixteen or twenty lubricators. In addition, by varying the length of each revolving contact segment, the pressure may be released when the lubricator has finished its stroke or sustained for a predetermined period after the finish of the stroke.

Each contact unit of the cylindrical sections is connected electrically to an automatic solenoid-operated valve. Then, when the brush makes connections with a certain contact, the solenoid is energized and the air valve to the required lubricator is opened. Thus, one control unit can operate sixteen or twenty solenoid-valve and lubricator units.

■ ■

Need for Adequate Industrial Lighting Stressed by Women's Bureau

EYES are the most important tool of the industrial worker; on their efficient functioning depends most of his usefulness. Yet workers' eyes are continually neglected and abused. Investigations of working conditions in about 1,300 industrial establishments, conducted by the Women's Bureau of the U. S. Department of Labor over a period of 10 years, have shown that a large number of plants have yet to solve the problems of securing good light, of protecting workers' eyes from strain, fatigue, and glare. Recognizing in these findings an urgent need for a more general understanding of lighting standards and practices, the Women's Bureau has recently issued a bulletin prepared by Marie Correll on the subject of industrial lighting.

The bulletin is designed to be of special interest and practical value to employers, workers, and State departments of labor, all of whom have contributed to its production. It constitutes a guide for improving the installation, maintenance, and use of lighting systems. It acknowledges that lighting is an involved technical problem requiring solution by trained persons but points out that the basic requirements for good lighting are few, always the same, and possible with equipment easily secured and maintained where employers display interest in an adequate lighting program.

Many employers are already aware of waste involved in inferior lighting equipment, according to the bulletin. Among the plants visited by the Women's Bureau were many in which the management was making a notable attempt to provide satisfactory lighting conditions. However, the lack of agreement as to what constitutes adequate lighting points to a need for the standardization of lighting practices.

Though standardization may be accomplished in part through the efforts of individual employers, it is apparent from the report that standardization on a large scale is greatly aided through the establishment of adequate minimum lighting requirements as a part of the State labor law, preferably through lighting codes.

Thirteen States have devised such codes, and in some cases these have been in use for 14 years, indicating that specific lighting regulations are practicable and can be applied in industry. A discussion of these codes and a comparison of their provisions with the American Standards Association code, which six of the States have adopted in its entirety or follow closely, constitutes an important section of the bulletin.

The study contains sources of information on lighting, charts of the State code requirements on lighting and recommended estimates of the amount of illumination necessary for industrial interiors and different types of work, and tables on sources and degrees of glare. The appendix presents a detailed analysis of the lighting provisions of all the States, helpful to those interested to ascertain the status of their own communities in this matter.

Mechanical Efficiency May Not Tell the Whole Story

GEO. P. PEARCE

GIVEN:

(1) A power drive with mechanical efficiency of 20 per cent.

(2) The limiting condition that improvement can be made on a maximum of two-year life.

TO DETERMINE:

The efficiency at which the cost of improvement will return the greatest net profit.

THE MILL room of a fairly well known foundry was a good example of what a mill room ought not to be. Everything was wrong. There were too many items to attempt to cover them all in one discussion, so we closed our eyes to everything but the question of power.

The 50-hp. motor that drove the mills had been put in the core room, which was about a hundred feet away. The reason for this, as nearly as could be discovered, was so it would be in a place where there was always some one to watch it and so a small Simson mill and a core wire straightening machine could occasionally be run from the drive shaft. The motor itself was bracketed to the wall and drove the power shaft by means of a belt that was kept tight by an idler pulley. The shafting was carried by drop hangers fastened to the steel roof truss and then, in the mill room, the power was belted back to the mill drive shaft and the mills themselves were driven by individual friction clutches.

A careful check-up revealed that the motor was very dirty and gummy with core oil fumes. Also it was very much overloaded and running at a temperature that would mean a rewinding job if continued long. The belt was glazed on the driving side and the idler had been tightened until the belt was as tight as a fiddle string. Shafting was so badly out of line that a common carpenter's level would show the ups and downs. Bearings were of babbitt and had at times "let go," with the result that the overworked plant millwright had rebabbitted every one by the simple process of repouring them in position. Nearly all were too hot to hold the hand on, although, judging from the puddle of black oil under each, plenty of lubricant was being supplied. The mill drive belt take-up had a chunk of iron, that would have made a substantial anvil, hanging on it to increase the tension and when a mill clutch was thrown in the operator would tie the steel shipper handle over as tight as he could with a piece of rope because, he said, otherwise the thing would slip. The mill dust caps had fallen off many months ago and the millwright had plastered on top of the exposed trunnions a couple of pounds of yellow grease which, when mixed with the sand that was everywhere, made an elegant grinding compound, as the badly worn bearings proved.

A rough estimate indicated that the mechanical efficiency of the whole drive, from electric power at the motor to the work of actually rotating the mills, was in the neighborhood of 20 per cent. That is to say, practically 60 hp. was being absorbed to do 12 hp. of work. This state of affairs had gradually been getting worse for years under everyone's eyes, but because it had happened slowly it had not been observed. The question was what should be done.

The first thing to find out, of course, was the cost of a motor horsepower year. This figure, including the cost of maintenance and repairs, turned out to be $60.

Next, seven proposals were prepared, as follows:

(1) To do nothing and let things run, as were.

(2) To realign the shafting, rebabbitt and ream all bearings, and clean motor. Estimated cost $200. This change, it was estimated, would increase the mechanical efficiency to 30 per cent.

(3) In addition to doing as per proposal (2) to install two new belt drives, using larger pulleys and wider belts. Estimated cost $800. Mechanical efficiency increased to 40 per cent.

(4) Same as proposal (3) but in

WHICH ONE OF THESE PROPOSALS SHOULD BE CHOSEN?

Proposal	Estimated Cost	Mech. Effic., Per Cent	Power Cost	Power Saving in Two Years	Net Gain or Loss
1	$ 0	20	$3,600	$ 0	$ 0
2	200	30	3,240	720	520 gain
3	800	40	2,880	1,440	640 gain
4	1,200	50	2,520	2,160	960 gain
5	2,000	60	2,160	2,880	880 gain
6	3,500	70	1,800	3,600	100 gain
7	5,000	80	1,440	4,320	680 loss

addition to replace the worn out friction clutches with new and larger ones. Estimated cost $1,200. Mechanical efficiency increased to 50 per cent.

(5) In addition to changes as per proposal (4) to replace the plain babbitt bearings in the mill room with special dust tight ball bearings. Estimated cost $2,000. Mechanical efficiency increased to 60 per cent.

(6) Eliminate shafting drive altogether and drive direct with special motor containing built-in ball bearing speed reducer, also install the new clutches and the ball bearings on mill equipment. Estimated cost $3,500. Mechanical efficiency increased to 70 per cent.

(7) Eliminate everything and install another type of automatic self-controlled mill. Estimated cost $5,000. Mechanical efficiency increased to 80 per cent.

The seven propositions were discussed at a meeting of the manager, superintendent, assistant superintendent, master mechanic, foundry superintendent, and mill room foreman. Each one had a different opinion. However, proposals (5), (6), (7) were the most strongly favored, particularly (7) on account of its high mechanical efficiency.

To get things down to a definite basis, it was decided that whatever was done would have to be figured on a two-year period. This would actually mean almost three years, because the greater part of a year would be taken in bringing about the improvements which would have to be done without interfering with production. There was the consideration that, after the three-year period, new or different methods would have been developed in which case quite different equipment might have to be purchased. Therefore the proposals were tabulated as shown.

The answer was immediately apparent. Proposal (4) was the one to accept for it showed the greatest saving in the period of time allotted. It increased the efficiency by only 30 per cent but it would make money for the company, whereas proposal (7) which, it was estimated, would increase the mechanical efficiency by 60 per cent, would, on account of its higher purchase and installation cost, actually result in a $680 loss.

This all goes to show that the mechanical efficiency by itself does not tell the full story from a purely financial viewpoint.

■ ■

Advocates Modernization to Break Unemployment Deadlock

(Chairman Robertson* drops a sledge on Maintenance Engineering's favorite nail—Ed.)

SAYS Mr. Robertson: "The progress of industrial maintenance has been interrupted to such a degree that today more than fifty per cent of the machinery, equipment, and plant facilities in American factories is obsolete. The fact that in these last three years there has been more rapid improvement in equipment design than in any period in our industrial history makes the condition that much more urgent. Replacement has not kept pace with this engineering advance.

"The Committee on Industrial Rehabilitation in its national program is stressing the advantage to the manufacturer in urging him to proceed at once with the modernization of his plant. Now is the best time for this step, for many reasons. In the first place, financial and credit conditions are clearly and positively better. Secondly, the most improved equipment developed in the last three years can be purchased at abnormally low prices. Again, many corporations have liquid funds drawing low interest that would be better invested in more profitable equipment and plant facilities. Better production efficiencies, effected through installation of modern equipment, will improve a company's ability to meet competition and increase its earning power. Changes can be made most easily now, when plants are not busy. Also, there is the important fact that obsolescence means not waste alone but loss of opportunity for better profits.

"The committee believes that if industry will proceed at once for reasons of sound self-interest to put its house in order and to remedy through modernization the run-down condition of its productive equipment, employment will be created for hundreds of thousands of workers in the 'capital goods' industries. In addition, it will bring back on pay-roll hundreds of thousands of other workers in industries which furnish the parts, raw materials, and services bought by these machinery and equipment manufacturers. This will release millions of dollars in wages spent for individual and family purchases affecting business in every community."

*A. W. Robertson, Chairman National Committee on Industrial Rehabilitation—Chairman of the Board, Westinghouse Electric and Manufacturing Company.

■

Photoelectric Relay Solves Conveyor Problem

A MANUFACTURER had experienced difficulty in the transfer of tote pans loaded with bolts, and weighing 70 to 150 lb., to a gravity conveyor. These pans are lifted by two endless chains with conveyor carriers, and are then lowered and placed on the gravity conveyor. Each pan when placed on the gravity conveyor should slide and make room for the next pan. But often this did not happen, which meant that the second pan was deposited on top of the first one, and so on, until a pile of material accumulated.

The problem was solved by installing a light source on one side of the gravity conveyor and a photoelectric relay on the other. Now, if a pan fails to slide along on the gravity conveyor, it interrupts the beam of light. The phototube promptly actuates the relay, stopping the endless chain, and allowing no more tote pans to come down until the blocking pan is shoved along.

In applications similar to the tote box control, the photoelectric relay could be arranged to actuate an electro-mechanical device to push the obstructing box on its way, automatically.

MAINTENANCE ENGINEERING

L. C. MORROW, Editor

OCTOBER, 1932

■

It's Up to Us—and Also You

GRATIFYING news appears frequently in the daily press. Last month came the announcement of the voting of $5,000,000 for replacements and improvements in equipment for plants of the U. S. Steel Corporation. About the same time the administration activities looking toward plant rehabilitaiton began to take definite form. There have been many reports of increased production of a diversity of products.

So it begins to look as though the program urged by *Maintenance Engineering* during the past three years is to go into effect. How else can products be manufactured with enough margin between cost and selling price to represent a fair net profit? Our program, you remember, calls for getting plants in shape by reconditioning existing equipment and by installing new equipment that will give the lowest unit cost of production.

Repeatedly we are told that maintenance has been forced to strip idle equipment in order to keep active equipment in operation. That practice can go on only so long. Then follows forced replacement—there is no more equipment to be stripped.

And when increased business compels the use of additional plant capacity, as it will, there is bound to be a serious rub, if maintenance and replacement policies have been lax. Orders will go on the wire, into the mail. Makers of equipment, parts, and supplies will be caught short. Deliveries will be slow. Overtime will add to costs. Orders will be lost.

Now it's up to somebody to prevent, so far as possible, the development of the unsatisfactory situation outlined. Up to *Maintenance Engineering* first, of course. Well, we've been at it, shall be. But next it's up to maintenance engineers. They have gone all the way in cutting expenses by saving, and by *not* buying — have done a splendid cooperative job. From now on, seems to us, it's going to be saving *by* buying—spending money to make money—getting plants ready for lowest-cost unit production, greatest net profit.

The Challenge of Pearl Street

FIFTY years ago, September 4, 1882, Edison's first commercial generating plant, historic Pearl Street station in New York City, began operation. With its six generators and engines, each rated at 125 hp., it was an outstanding achievement. Direct current was transmitted at 110 volts over an area of about 1 mile square through crude underground cables.

Technically we have gone a long way since Pearl Street station was a seven days' wonder; actually only a small part of the field has been covered. One can only conjecture what new applications and developments will be made in the next 50 or 100 years. Such speculation may be intriguing, but right at hand there are plenty of opportunities to extend the applications of electrical energy in industry and eliminate the present wastes in its use. There indeed is undertaking whose possibilities should appeal to the most ambitious.

■

Exit Whims and Guesswork

WHEN orders are abundant, money plentiful, oftentimes hobbies and whims can be indulged in with some safety; mistakes may remain undiscovered, or easily be condoned. In short, when the big problem is to obtain sufficient production many details escape serious attention.

For many years industry enjoyed that situation. Frequently cold engineering facts were diluted with vanity, personal preferences, all sorts of human qualities and failings, when the matter of building a new plant or buying equipment came up. Whether such conditions are desirable is quite beside the point; they have definitely passed and are likely to be out of the picture for a long time to come.

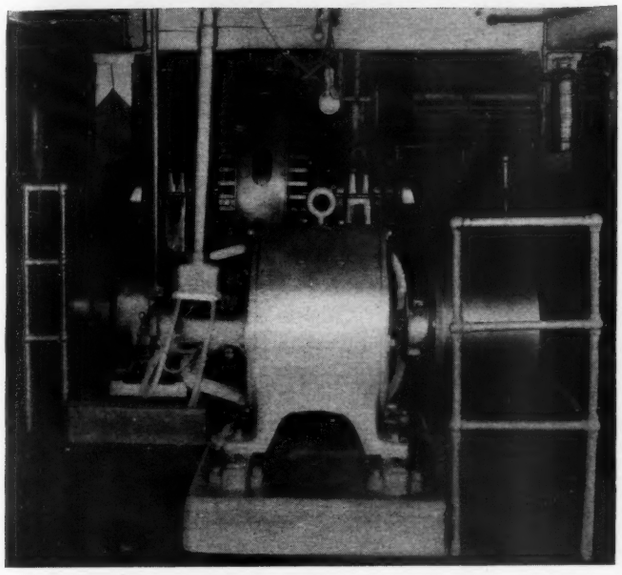
Unless all signs fail, engineering analysis of a high order is going to crowd out guesswork; equipment of all kinds will be purchased on the basis of guaranteed performance, reliability, low operating and maintenance costs. Personal preferences and favoritism in any form can hardly be eliminated entirely from human relationships, but their effect can be lessened greatly by the relentless necessity of justifying by results every decision made, every dollar spent.

If this situation puts equipment manufacturers on their mettle as never before, the responsibility of maintenance engineers is likewise increased. Upon them falls the duty of keeping abreast of all developments in many fields, of investigating requirements more thoroughly, choosing equipment more carefully, keeping it in better condition.

MAINT-O-GRAPHS

Equipment efficiency ◆ Ideas ◆ Books and events ◆ Plant problems ◆ Design developments

CONTRIBUTIONS ARE WELCOME



How This Plant Corrects Its Power Factor

FRANCIS A. WESTBROOK, New York, N. Y.

When the public utility which serves the Windsor, Vermont, plant of the National Acme Company placed in effect a penalty for power factors under 80 per cent and a rebate for those averaging 95 per cent or better on the monthly period, measures were taken immediately to win the rebate.

There are one hundred and fifty induction motors at the plant ranging in size from those of fractional hp. up to 100 hp. A high power factor could not be hoped for unless special apparatus were installed.

The first step taken by the plant electrical engineer was to go over all the motors and check up the relation of each motor to its loading. By a rearrangement of these loadings 400 hp. of rated motor capacity was eliminated. This of course greatly helped the power factor, for, as is well known, under-loaded motors have a very bad effect.

The next step was the installation of five synchronous motors, as follows:

1—100 hp. driving a line shaft
1— 75 hp. driving an air compressor
1— 75 hp. Fynn-Weichsel motor driving a line shaft
1— 25 hp. Flynn-Weichsel motor driving a line shaft
1—250 kva. synchronous condenser driving a 50-kw. d.c. generator (shown in the illustration).

To the line shafts driven by these motors are belted grinding machines requiring constant speed. At present, under normal operating conditions, the power factor is between 0.99 and unity. This means that a penalty of $400 a month has been replaced by a rebate of $150 under full load operating conditions.

■

Protected Rivets for Galvanized Steel

SOURCE: American Zinc Institute

A method has been provided whereby the individual units of riveted steel structures may be hot-dip galvanized before assembling, joined together by riveting in the usual manner (using the ordinary uncoated rivets) and the exposed rivet-heads then sealed off from the weather after the entire job is assembled in the field.

This method employs a circular flanged cap, formed from heavy-gage rolled zinc, which fits snugly over the rivet-head. The cap is fastened to the galvanized surface of the structural shape through which the rivet passes by means of a continuous ring of solder, thus completely sealing off the rivet-head from the atmosphere. Application is by means of a gas or electrically heated, specially shaped soldering iron, so designed that the cap may be attached regardless of the position of the rivet. Caps are designed to fit various shapes and sizes of rivet-heads, with a heavy ring of solder already attached to the under side of the cap flange.

■

Power Show This Year

The Tenth National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, Dec. 5 to 10. The management reports that 305 firms have agreed to exhibit.

■

Foreman's Safety Conferences

A publication presenting a method being used to develop safety interest among foremen and others in supervisory positions. Offers suggested programs for a series of seven informal conferences to discuss the vari-

ous phases of safety work, these meetings to be presided over by works manager, general superintendent, or director of safety. A series of nine questions is presented for each of the seven conferences.

Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York, N. Y.

■

Rewinding Small Motors

A thoroughly practical book that should be in the library of every one who is concerned with the rewinding or repairing of small single- and polyphase motors. 263 pages, with numerous tables, diagrams, and photographs.

In this edition, the second, an appendix has been included, giving details of the operating characteristics and construction of the capacitor type motor. Included also are details on the elimination of radio interference from small motors, with data on some special types of motors not discussed in the first edition. Many suggestions received from readers have been incorporated throughout the book and the complete text has been brought up to date.

Daniel H. Braymer and A. C. Roe, authors. McGraw-Hill Book Company, 330 West 42d St., New York, N. Y. $2.50.

■

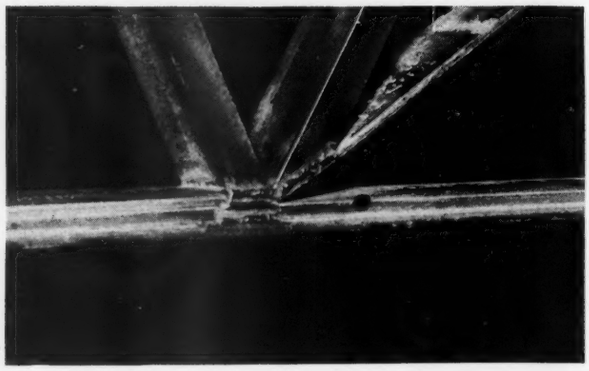
Welded Truss Design One-Third Lighter

SOURCE: Westinghouse Electric and Mfg. Company
East Pittsburgh, Pa.

Saving in weight of one-third in comparison with trusses of accepted design is claimed for the welded roof truss consisting of continuous tension straps as illustrated.

In construction the truss is an expansion of the king-post principle. The 52-ft. truss, which the Westinghouse Company is to use in a new building, is composed of an upper compression member, three continuous tension straps, and twelve short struts, fabricated by combination butt and fillet welds.

The struts are welded to the top chord at purlin points and converge in pairs at the bottom chord, thus forming six isosceles triangles. The six diagonal tension members and the bottom chord of the truss (also tension members) are made from three steel straps. These



straps, the ends of which are welded to the top chord at corresponding points on opposite ends of the truss, run diagonally downward and inward to the point of convergence of the two immediately adjacent struts, and then along the truss in the plane parallel to the top member, thus forming the bottom chord. This method of running continuous tension straps to corresponding points on opposite ends of the truss automatically increases the cross-sectional area of the bottom member in proportion to the load which it carries.

■

Synthetic Rubber Cable Jacket

Electric cable with a jacket of "Thiokol" (characteristics of rubber—*M.E.*, July, 1932, p. 299) will be introduced soon by General Cable Corporation, New York, N. Y. Resistance to chemical action, fatigue, sunlight, oil, vibration, and corona are claimed as advantages.

Reported is development work to complete the adaptation to power cables, overhead conductors, secondary network conductors, wires in general industrial applications.

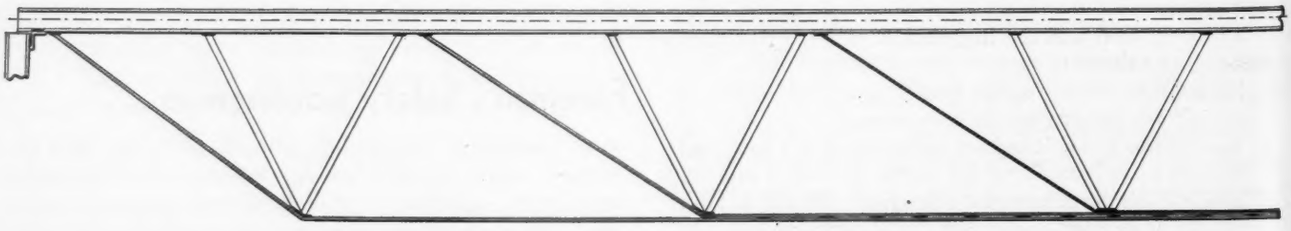
■

Revamping Obsolete Compensator

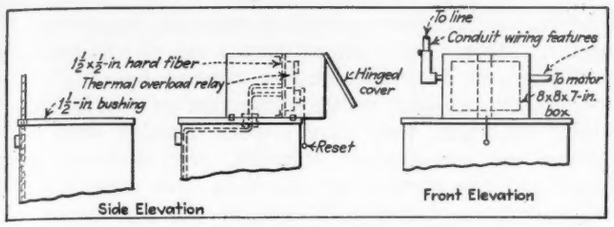
H. E. STAFFORD, Electrical Engineer
Port Arthur, Ont., Canada

Recently a small industrial plant purchased a quantity of second-hand motors and compensators. A number of the compensators were of an almost obsolete type, with their leads brought out through the tops and with only no-voltage protection.

These compensators were brought up to date in the



manner illustrated in the sketch. The cover of one unit was removed and holes were drilled in it for mounting a steel cabinet used for housing a thermal overload relay. The cabinet measured 8x8x7 in. and provided ample room for all connections. The compensator wiring was brought through the cover and into the cabinet through



a 1½-in. nipple, and the original wiring opening was sealed with a strip of sheet metal brazed to the cover.

A strip of hard fiber, 1½ in. wide by ½ in. thick, was fastened by metal strips and stove bolts at the center of the cabinet, after it had been drilled for mounting the relay. In this way ample room was obtained for removing the relay and connecting and disconnecting the leads at the back. The resetting cord was brought through the bottom of the cabinet and hung in front of the compensator, so that it was not necessary to open the hinged cover to reset the relay after tripping.

Thus an obsolete type of compensator was modernized by providing overload and no-voltage protection and conduit wiring features at a total cost of $20, and the whole assembly has a much neater appearance than before.

■

Monorail Conveyor Speeds Up Switchboard Assembly

The general arrangement of the monorail system for switchboard assembly in a plant of the Western Electric Company is such that it forms a closed loop. On the side of the loop shown pedestals are provided for holding the carriages or trolleys rigidly in position during assembly work. On the return side five rails are provided for switchboard adjusting, testing, and inspection. All of these rails converge into a single rail at one end of the loop where each switchboard is removed from its carriage by an electric hoist. The empty carriage is then returned to the starting position in front of the frame assembly bench.

The carriages are built of seamless steel tubing with all castings, braces, and trolley couplings welded in assembly.

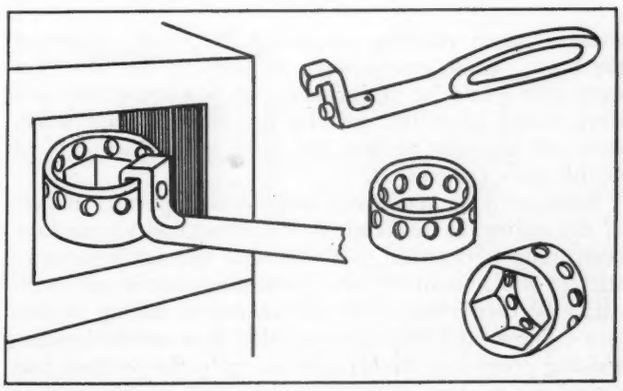
■

Close-Quarter Socket Wrenches With Unlimited Grips

CHAS. H. WILLEY, Penacook, N. H.

Until designers provide plenty of clearance for the use of suitable wrenches on nuts and cap screws in almost inaccessible places, a normal amount of ingenuity will have to be exercised in accomplishing certain assembly work.

A type of wrench used to good advantage in some erection work is shown in the accompanying sketch.



The common handle fits various sizes of socket wrenches. The action is almost similar to that of a ratchet. The limited movement of the ordinary wrench is overcome by the number of extra grips possible.

■

Bronze-welding a Fractured Engine Base

SOURCE: Linde Air Products Company

Circumstances occasionally arise when making a large welded repair to gray iron castings that make preheating for stress relief impractical, so that other means must be devised to equalize stresses that are set up by the welding heat.

An interesting case of this kind recently occurred in

a lumber camp in the Northwest when a large cast iron diesel engine base was broken. Although the plant officials felt that it would be impossible to repair it and were quite prepared to order a new base at a cost of about $2,000, they decided first to obtain the advice of a welder. Upon his recommendation, the repair was made by bronze-welding, under his supervision.

An inspection of the casting showed a number of fractures along the bottom part in various directions,

some of them running practically the whole length of the base. These cracks were in parts of the base that were only ½ to ¾ in. in thickness. A few more fractures were found after the welding had been started which were not apparent at first, but these were taken care of as the work progressed.

Because of the mounting, size, and complicated nature of the engine, to dismantle it for preheating would have been quite impractical. It was also felt inadvisable to attempt the amount of local preheating that would ordinarily be used even in bronze-welding a casting of this size. The welder felt, however, that by a careful bronze-welding procedure, the stresses set up by the welding heat would not be too great to be equalized as the welding progressed.

For this particular bronze-welding job, only a very small section was welded at a time and as the weld cooled, the bronze weld metal was stretched, or peened, with a hammer. In this way the force of the hammer blow compressed the weld metal. This stress was thus transferred laterally to the base metal and helped to counteract the contraction stresses of cooling.

■

The Utility of Cane Sugar in Mortar

In a paper, presented recently before the Sugar Division of the American Chemical Society, Drs. Gerald J. Cox and John Metschl of Mellon Institute of Industrial Research discuss their investigations of the value of cane sugar when used for strengthening lime-sand mortar. Such an application of sugar is not considered to be new because it is believed that the Romans made use of saccharine materials in mortars that have stood the test of time. Also, in several sugar-growing countries, sugar has been employed to increase the strength of mortar.

Drs. Cox and Metschl have found that there is a good reason for the empirical practice of "sweetening" mortar. Mortar that contains an amount of sugar equal to 6 per cent of the quick-lime content has a tensile strength 60 per cent greater than that of mortar containing no sugar, they have found. Further tests are planned of compression strength, setting time, and durability of mortars as influenced by cane sugar.

The process of mixing the sugar with the mortar is quite simple. The sugar is first dissolved in part of the gaging water and mixed in with the sand and lime. The sugar must not be mixed with the lime before slaking.

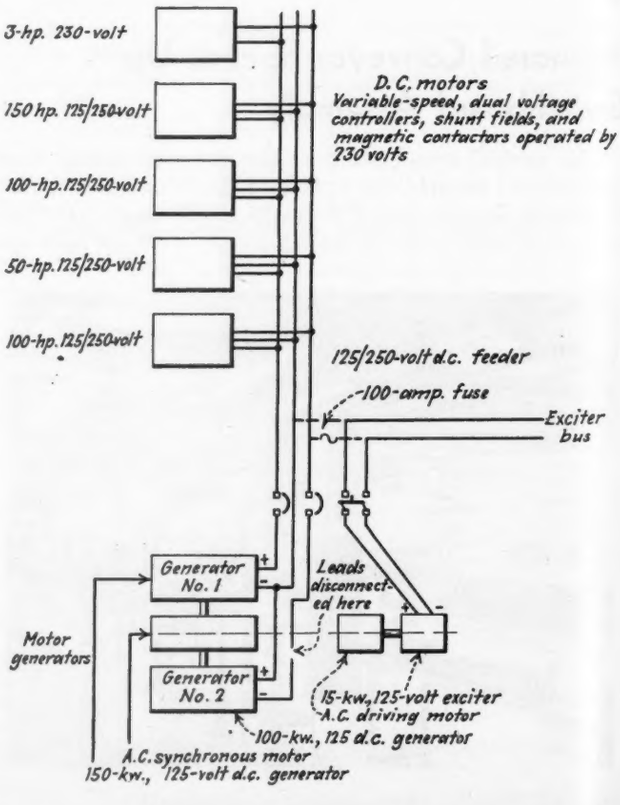
With the present low price of sugar, the 5 or 6 lb. of sugar necessary for 100 lb. of lime is only a small addition to the cost of laying bricks or plastering a wall.

■

Emergency Generator Arrangement

GEORGE D. NOILES, Hudson, Mass.

Recently generator No. 2, as shown in the sketch, had to be taken out of service for two days for armature repairs. Because there was no standby unit it was necessary to operate the motors at one-half sped on generator No. 1 alone.



To effect this arrangement we had to connect generator No. 1 to the exciter bus in order to supply 250 volts to operate the magnetic contactors of the d.c. controllers, the 3-hp. variable-speed motor, and the shunt fields of the other motors.

To prevent overloading of the exciter the high-speed contactors were disconnected, and the operators were instructed to run only on the low-speed side of the controller.

This arrangement worked very well considering the fact that it saved a complete shutdown.

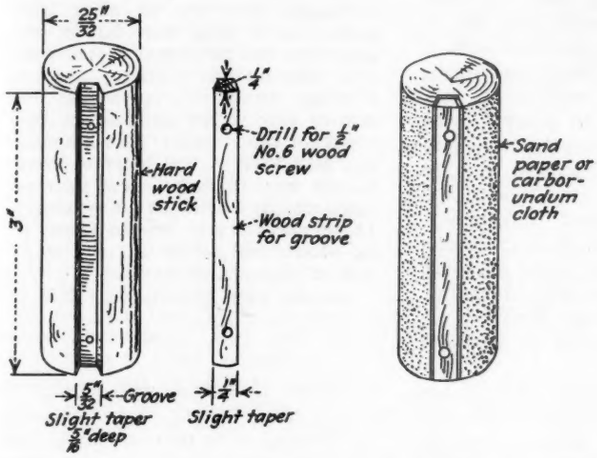
■

Cleaning Cartridge Fuse Clips

R. W. Schuster, Carbondale, Pa.

It is necessary to keep fuse clips bright and clean, and a handy device that will make it easier to do so can be made from a piece of hardwood, such as a hammer handle, turned down to the size indicated, which is suitable for a 60-amp. fuse. The dimensions can be changed as needed for other sizes.

After the stick has been turned down cut a lengthwise slot about $\frac{5}{32}$ in. wide and $\frac{5}{16}$ in. deep. Cut a



strip of fiber or hardwood about $\frac{1}{4}$x$\frac{1}{4}$ in. to fit into this groove. Two holes should be drilled and countersunk for $\frac{1}{2}$- or $\frac{5}{8}$-in., No. 6 wood screws.

A piece of abrasive cloth long enough to encircle the stick and overlap both sides of the slot is then placed around the stick; holding it as tight as possible insert the strip and put in the screws. Either sandpaper or carborundum cloth can be used; it should be of the finest grade.

To clean clips, remove the fuse, insert the cleaner and run it back and forth a few times, turning it meanwhile. If the cleaner is made the same size as the fuses the small amount of material that is removed from the clips will tend to make a more perfect fit around the fuse. By removing the cleaner after a turn or two and noting where the abrasive cloth is hitting, one can tell how much of the clip is making contact with the fuse and thus determine whether adjustment is needed.

Operator's Cab Travels With Crane Hook

Source, Western Electric Company

By arranging the operator's cab of a 5-ton, 95-ft. span electric crane so that it travels with the load, materials handling has been simplified in the merchandise building of the Western Electric Company, Kearny, N. J. The hook is attached to a perforated plate in the floor of the cab and can be rotated by the operator's feet.

■

Trouble With Small Brush Pigtails

Melford Hansen, Duluth Minn.

A type SCR single phase General Electric motor had been in a shop for repairs, when a new set of brushes had been installed. The first trouble call on this motor revealed that the brushes were stuck in the holders, allowing heavy sparking and giving low starting torque. After the brushes were loosened in the holders the motor operated normally again. But about three days later the same trouble developed. It was then found that the pigtails on the brushes were approximately one half of the correct size. Their overheating caused burning between the brush and holder and eventually caused the brush to stick in the brush holder. New pigtails were installed and no further trouble was experienced.

QUESTIONS and ANSWERS

Conducted by
G. A. VAN BRUNT
Associate Editor

Please submit answers promptly. We expect to publish no answers later than the second issue after the appearance of the question. Selection will be made on the basis of quality, but answers first received have the best chance of being used

■

Removing Fins from Commutator Bars

I wish readers would explain the best methods of removing fins from commutator bars after undercutting, covering both square and V-slots. I am especially interested in the methods used by steel mills and railroads. How can this work be done most effectively and economically in a plant containing about 100 d.c. motors up to 25-hp. rating?

Can spiral grooves be cut in an old or newly refilled commutator without elaborate or expensive equipment? R.D.

Chicago, Ill.

How Control Maintenance Department Tools

We are making a survey of our maintenance tools and equipment and the system of controlling them, and should like to know the practice of other companies on these points:

1. What method of control is used for company-owned tools and equipment?

2. What tools are furnished to millwrights, carpenters, electricians, and other maintenance workers?

3. What arrangements are made for employees to borrow company-owned tools for personal use after regular working hours?

4. Are departmental foremen furnished tools for miscellaneous maintenance work in their department?

5. What tools are furnished machine operators (not machinists or tool makers)?

6. If a maintenance tool is broken by an employee's negligence or misuse, is he required to replace it?

Decatur, Ill. **W.T.A.**

Colored Concrete Floors

We are considering using concrete colored green, red, or blue for the floors of some offices and possibly other areas, in order to give a more cheerful effect. Can readers tell me out of their experience: (1) Will the use of coloring material in concrete injure its wearing qualities? (2) Will the color fade? (3) Is it necessary to use any finishing coat, such as varnish? (4) Are any special precautions necessary in preparing the concrete and laying the floor? F.J.L.

Philadelphia, Pa.

Two types of concrete coloring are on the market: One is a mere coloring that makes no pretense of hardening the surface and may have a slight weakening action. The more modern type is a combination coloring and hardener that increases the strength and life of a concrete floor, in comparison with a plain concrete surface. Where maximum strength is desired a coloring of this type should be used. In general, with good products and expert workmanship coloring will greatly increase the life and serviceability of the floor, and retain its color almost indefinitely. However, certain types of concrete coloring require additional water to insure workability and this may lead to dusting, resulting in a film being deposited on the surface which destroys the intensity of the color.

Where an easy-to-clean, smooth finish is desirable it is recommended that the floor be waxed or oiled. Great advances have recently been made in the finishing treatment; now a method is available by which the concrete is waxed when it is still damp and polished after curing, resulting in a beautiful surface that requires minimum maintenance.

Laying colored concrete floors is more or less a specialized job and only contractors who have had thorough experience in this work should be relied upon when maximum satisfaction is desired. Good troweling, slow curing, and thorough mixing of the color are the points that need watching.

Recent discoveries have brought the price of colored concrete floors down to the cost of a plain cement floor with two coats of paint. Of course, painted floors have to be repainted once or twice a year, which is costly, whereas a colored concrete surface requires no maintenance for the life of the building, with the exception of occasional waxing. The fact that colored concrete floors are used in thousands of the most modern buildings is ample testimony of their worth.

DOUGLAS W. CLEPHANE
The Master Builders Company
Cleveland, Ohio

■

Operating D.C. Portable Drills on A.C.

We wish to operate two portable electric drills rated 250 and 230 volts d.c. on 220-volt, 60-cycle, single-phase current. Under the impression that any series motor would run satisfactorily on single-phase a.c. if the voltages were about the same, both drills were tried out. Although they ran at about the proper speed they immediately became hot and there was a considerable amount of sparking at the brushes. It appears to me that the size of wire in the windings is too small for the voltage. I wish someone would tell me (*a*) whether there is any way to make them operate satisfactorily without rewinding; (*b*) if necessary to rewind would it be economical to do so; (*c*) what size of wire should be used.

Mountain Park, Alta., Canada **G.N.**

I suspect that these drill motors use the cast-iron frame as part of the magnetic circuit. If so they cannot be made to operate successfully on a.c., even though they are rewound. Eddy currents would be set up in the iron frame due to the constantly changing value of the magnetic flux, which would account for the heating noted.

Inspection of the machines will show whether the motors are of this type. If they are, the only thing to do is to exchange them for other motors designed for a.c. operation, unless some source of d.c. power is available.

Series motors with laminated magnetic circuits will operate on a.c., but unless properly designed they are likely to show considerable sparking at the brushes. The magnetic flux from one pole is passing through a coil which is in the commutating position and short circuited by a brush. The flux

is changing rapidly; hence a heavy current will be induced in this coil while it is short circuited, and sparking will occur at the brush when contact is broken. That will cause heating. These conditions may be improved by:

1. Using brushes with a high contact drop, such as National Carbon Company's grade 250 or 400.

2. Reducing the thickness of brushes where they make contact with commutator to about two-thirds of the present value. This will reduce the duration of the brush short circuit.

3. If the brush-holder is adjustable, or can be readily made so, move it to the point of minimum sparking. No data are given regarding the make or size of these motors on which to base any suggestions for changing the windings. If the magnetic circuits are laminated and satisfactory results cannot be obtained by such measures as outlined, I suggest that G. N. write to the manufacturers for their recommendations.

M. WOFFINDEN
Salt Lake City, Utah

■

Motor Bearings Heat

A 10-hp. 1,150-r.p.m., squirrel-cage motor has been giving trouble from heating of the bearings. The bearings are made of bronze, and have circular oil grooves and two oil rings. Upon removing them a highly burnished spot in the bottom seemed to indicate lack of lubrication. We cut two grooves in the bottom of the bearing, extending from one drain groove to the other, and drilled three ⅛-in. holes in the bottom of the drain groove at each end of the bearing. The idea was to help the oil to circulate more rapidly, but upon running the machine we found that the bearings still heated. Draining the oil and putting in a mixture of castor and lubricating oils did not help matters.

At no time have these bearings become alarmingly hot, but the temperature is very uncomfortable for one's hand and we are afraid that it might result in serious trouble. What can be done to correct this condition?

R.E.L.
Dallas, Tex.

It is not stated whether the motor is direct-connected or power is transmitted by belt, chain, or gears. This factor may have considerable influence on the possible cause of the trouble.

In any bearing the object of the lubricant is to make a film between the shaft and the bearing, and this film must be maintained on the side of the bearing on which the shaft presses. There must be no holes in the bearing shell on the side of greatest pressure, since they will allow the oil to be squeezed out. The oil must be introduced at the side of the bearing opposite to that of greatest pressure. If the bearing in question has standard oil rings but the load is transmitted by belt vertically upwards the greatest pressure will be on the upper side of the bearing and would tend to prevent the oil from getting in between the bearing and the shaft.

The grooves and holes cut by R. E. L. would let the oil escape, rather than maintain an oil film. Since there is a burnished spot at the bottom of the bearing, it appears that the direction of the load is vertically downward. The points to check are: alignment of the bearings, free running of oilrings, grade of oil, and vertical load on the bearings. If the motor is direct-connected to the drive unit, even with a flexible coupling, a small misalignment will be enough to cause the bearing to heat.

C. E. OLIVE
Chief Engineer,
Canadian Celanese Limited
Drummondville, P. Q., Can.

The burnished spot on the bearing is a hot spot, and does not necessarily indicate lack of lubrication.

The bearing should be bedded to the shaft by smearing a very small amount of some marking, such as red lead, evenly over the shaft. Then one-half of the bearing should be rocked to and fro while pressed tightly against the shaft to obtain markings which will indicate the high spots on the bearing. These spots should be scraped until there is an even marking over at least 90 per cent of the bearing surface of each half bearing. One-half of the bearing should be bedded at a time.

C. F. GIRDLESTONE
Kapuskasing, Ont., Canada

Two grooves cut in the bottom of the bearing linings and extending from one oil groove to the other will, it seems to me, defeat their purpose of insuring sufficient lubrication at the bottom of the shaft. What little oil is pulled around to the bottom will escape through these grooves and will be drained off at the ends.

I suggest that R.E.L. give the bearings a little more clearance on the sides around the oilrings. This space will allow more oil to be pulled around under the shaft. It might also be necessary to give about 0.002 in. more clearance on the bore, since bronze bearings expand more than babbitt bearings. If he will tin the ends of the grooves, close them about ⅜ in. from the ends, and scrape the sides down to an easy V I believe that the bearings will operate more satisfactorily than at present and the heating will entirely disappear.

I am assuming that the motor is direct connected, or that there is no heavy belt pressure that would cause the heating. Of course, if the shaft is sprung, or the motor is not lined up properly, or the pulley is out of balance, bearing trouble will result.

WILLIAM B. CONE
Chief Electrician
Shevlin-Hixon Company
Bend, Ore.

The statement that these bearings have never become "alarmingly hot," but just "uncomfortably hot," brings up the old question of "how hot"? Is a bearing really overheating simply because it feels uncomfortable to the hand?

A normal motor bearing should show a maximum temperature rise of not more than 35 deg. C. above ambient temperature. A maximum safe temperature is 75 deg. C. to 80 deg. C., although motor bearings will often operate safely around 90 deg. C. to 100 deg. C. Now, 75 deg. C. corresponds to 167 deg. F., and that is uncomfortable to the touch. I suggest that R.E.L. measure the temperature of the bearings by means of an instrument-type thermometer.

Some possible causes for overheating of the bearings are:

1. If a belt drive is used the belt may be too tight. It may be unnecessarily tight, or heavy tension may be necessary to prevent slipping due to operation on short centers or with a smooth steel pulley. In this case a paper or similar pulley should be used.

If a leather belt is used the application of neatsfoot oil will soften it and permit operation under lower tension.

2. The pulley, pinion, or sprocket used, depending on the type of drive, may be too small in diameter, thus working the bearing under too high a pressure. Live load on a bearing of this size may normally be around 180 lb. per sq.in. If a pulley is used it should be not less than 8 in. in diameter with not more than 6¾-in. face, except under very favorable conditions.

3. Improper oil. There are many good oils on the market and it should not be difficult to obtain a satisfactory grade. It is necessary that the lubricant be of correct body at the operating temperature in order to form a film just sufficient for lubricating the bearing surfaces. An oil that is too high in viscosity creates internal friction with consequent loss of power and generation of heat. On the other hand, oil that is too low in viscosity will not "stay put" or provide a film adequate to prevent wear and excessive friction. An oil suitable for this motor should have a viscosity SUV—38 deg. of about 200 seconds and a pour point of about 35 deg. Fahrenheit.

4. Insufficient supply of oil carried by the oil rings. One oil ring per bearing should be ample for this size of motor, and if they are operating properly they should supply sufficient oil to the bearings.

5. Bearing clearance. A bronze bearing of this size should have a clearance of around 0.0035 to 0.005 inches.

Grooves should not have been cut in the bottom of the bearing, from one drain groove to the other. A groove in the bottom of the bearing surface breaks the oil film and reduces the lubricating effect.

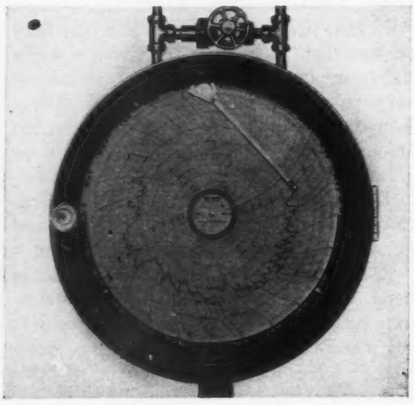
R. P. GUILDFORD
General Engineer
Westinghouse Electric & Manufacturing Co.,
Philadelphia, Pa.

EQUIPMENT NEWS

Mechanical Flow Meter

Available in combinations including: square root and evenly divided charts; automatic planimeter; multipen-flow-pressure-temperature; compensation for pressure and temperature; automatic control and recording.

Features: simple, direct lever-actuating mechanism; large float; pressure-



tight bearing with grease reservoir; range can be changed without disturbing orifice; manometer may be cleaned without altering calibration. Recording models available with spring clock or 60 r.p.m. synchronous electric motor drive, in variety of chart speeds. Control models operate mercury switches, will handle 15 amp., 110 volts, without use of relays. Mechanism mounted in die-cast aluminum case.

Adapted for mounting on floor stand, wall bracket, or pipe saddle. The Brown Instrument Co., Philadelphia, Pa.

■

Crane Limit Stop

To prevent over-travel of the hoist on electric cranes. Has standard mill-type blowouts and contact tips.

Rated 40 hp., requires only 9 in. headroom. Supplied with leads equipped with soldering lugs. Cover is removable for inspection and repairs. Cutler-Hammer, Inc., Milwaukee, Wis.

■

Hydraulic Coupling

Known as Model FD, for variable-speed fan drive. Represents a development of the "Vulcan" coupling principle. Usually applied to installations using a constant speed squirrel cage motor or a synchronous motor. It is stated that a speed range from 20 to 98 per cent of the driver is obtained in the driven shaft in steps as small as desired.

There is no mechanical connection between the driving and driven halves, power being transmitted by the kinetic energy of the liquid discharged by the impeller directly against the vanes of the runner. Upon the amount of oil in the coupling depends the speed of the driven member. Means are provided for lowering or raising the controlling weir by hand or by remote control. Hydraulic Couplings, Inc., Detroit, Mich. Marketed by American Blower Co., 6000 Russell St., Detroit, Mich.

■

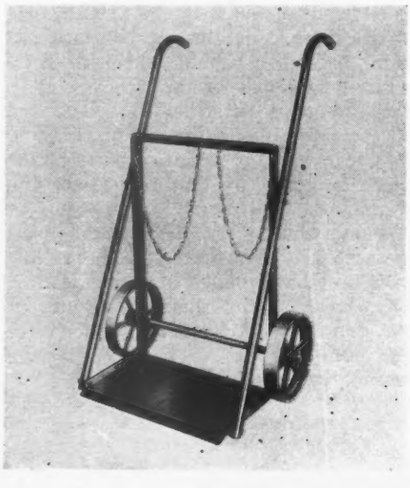
Portable Belt Conveyor

For handling loose material. Improvements and features include fixed steel retaining sides, all-metal troughing type idlers with roller bearings, pressure lubrication, foot end redesigned to keep material away from the return run of the conveyor belt. Machine may be used with or without the foot end plate. Conveyor has 21-ft. centers, uses belt 18 or 24 in. wide. Electric motor driven; can be arranged for gas engine drive. Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.

■

Welding Truck

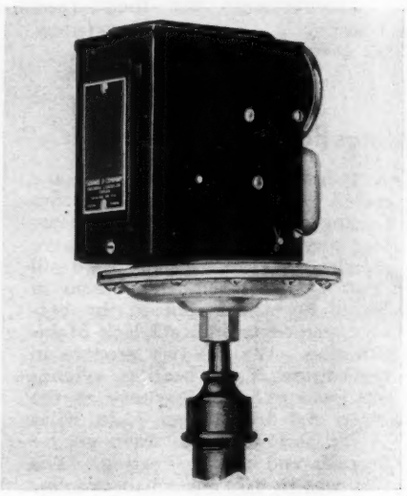
A cylinder truck known as No. 5, on which to transport oxyacetylene welding and cutting equipment. The frame is of $1\frac{1}{4}$-in. angle iron welded into a permanent unit and welded to a beveled steel plate which forms the cylinder platform. Handles are of $1\frac{1}{4}$-in. pipe and are bolted to the platform and frame for easy dismantling. Cylinders are held in position by adjustable chains. Wheels are of cast iron. Overall height, 48 in.; width 30 in.; weight 80 lb. Linde Air Products Co., 205 E. 42d St., New York, N. Y.



■

High Water Alarm

Single-pole pressure switch, transformer, signal bell mounted on 1-in. pipe over sump or open tanks. As liquid rises in pipe air pressure on switch diaphragm closes contact and bell rings until high liquid level has been reduced to safe limit. Switch designated Class 9036H1. Square D Company, Industrial Controller Division, Milwaukee, Wis.



■

Disk Switch

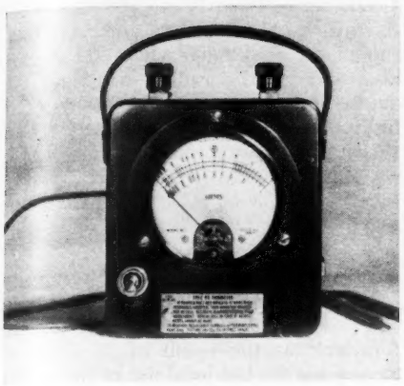
Advantages include front operation, small mounting space. Quick-make and quick-break action. Available fused or unfused. Copper switch contacts reinforced by rustless steel springs.

Rated 30 or 60 amp., single-pole, two-pole, two-wire solid neutral or three-wire solid neutral. Square D Co., Detroit, Mich.

■

Direct-Reading Ohmmeter

Self-contained, measures ohms directly. Resistance ranges of 5,000 and 50,000 ohms selected by toggle switch. Powered by 1.5-volt flashlight cell, with



means of adjusting for change in cell output.

Applications: resistance measurements, locating open circuits, short-circuits, grounds in electrical circuits and equipment. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

■

Motors and Generators

Manufacturing rights for the entire line of "Northwestern" motors and generators, formerly produced by the Northwestern Manufacturing Co., of Milwaukee, have been acquired by the Harnischfeger Corp., Milwaukee, Wis.

■

Switchgear

Switchboards employing air circuit breakers for control and protection of power and lighting lines. Breakers are trip-free, manually or electrically operated. Ratings up to 750 volts, 4,000 amp. a.c., 6,000 amp. direct current.

Available in three types: dead-front, metal-inclosed, and metal-inclosed draw-out types.

Structures made of formed metal plates, reinforced and welded. Metal partitions isolate each breaker. Doors are flanged, have ventilating louvers, and are hinged to permit access to the breakers. Switchboards are shipped completely assembled. General Electric Co., Schenectady, N. Y.

■

Pressure Aerating Filter

For the removal of iron and odors from water by pressure aeration and filtering. The water is pumped directly into a pressure filter tank, the top portion of which is filled with compressed air. As the water sprays through the compressed air it absorbs oxygen to oxidize the ferrous iron to the ferric state. The water then falls into the central section of the tank which acts as a retention chamber. During the passage of the water through this chamber coagulation takes place. The water then drops to the sand surface in the lower part of the tank for the iron to be filtered out by the sand. Filtering is at the rate of 3 gallons per minute per square foot of sand area. Elgin Softener Corp., Elgin, Ill.

■

Press Drive Control

For operating magnetic clutches and brakes of punch and forming presses. Safety feature is a number of palm-operated push buttons mounted on the slide of the press, so that both hands of operator will be occupied.

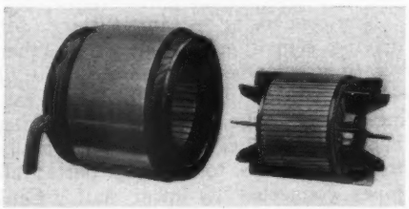
Three additional methods of operation provided, with means of transferring to any one of the four methods. Claimed that control permits spotting to within $\frac{1}{32}$ in. For automatic feed control may be set to run press continuously. Equipped with stop button for emergency use.

Mill-type switches, 100 amp., control coil circuits of clutch and brake. Control relays eliminated and electrical interlocks kept to minimum. Cutler-Hammer, Inc., Milwaukee, Wis.

■

Rapid-Reversing Squirrel-Cage Motors

Claimed is ability to make 60 reversals a minute continuously without overheating, because of light-weight rotor construction, efficient ventilation,



high torque characteristics, shock-resisting, cast-iron frames.

Available in standard open ball-bearing type, rolled-shell shaftless type shown, and in vertical, single-speed, multi-speed, inclosed fan-cooled, and other types. The Louis Allis Co., Milwaukee, Wis.

■

Smoke Density Meter

Comprises sampling tube which is inserted in stack and contains light source and photo-cell, a control panel, and indicating or recording instrument. As smoke varies in density, amount of light falling on photo-cell also changes, and resulting current variation is transmitted to the meter. Electric light bulb operates on 6 volts; made for use in temperatures up to 600 deg. F. Reflector is chromium plated. Reflector and lamp gasketed to protect from flue gas.

Photocell does not require auxiliary source of energy, vacuum tubes, or amplifying circuits. Will operate standard Brown indicators or recorders. Can be arranged to operate signal lamps, bell, or other alarm device.

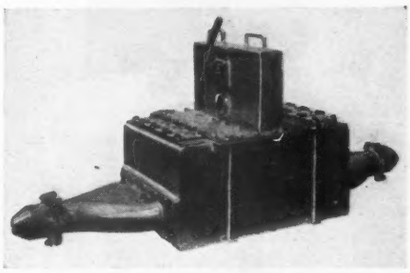
The Brown Instrument Co., Philadelphia, Pa.

■

Disconnecting Switch

Rated 7.5 kv., 600 amp., oil-immersed: for underground or pole-top service. The switch mechanism on top of the steel housing can be withdrawn for inspection. Bypass plugs are provided so that the load need not be dropped when switch is removed from tank.

A steel plate which moves down with the switch-blade mechanism grounds on the steel tank and places a barrier be-



tween switch contacts. Surges on the live side of the switch sufficient to break down the oil go to ground and cannot induce voltage on the disconnected contacts. Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.

■

Portable Crane

Rated capacity, 4,500 lb., single part line. Average hoist speed, 47 f.p.m. Traveling speeds, 1.8, 2.6, 3.6 m.p.h. Maximum drawbar hp., 26. Overall dimensions, width 66 in., length (exclusive of boom and operator's seat) 106 in., height 9 ft. $1\frac{3}{8}$ in. Power-operated, full-revolving boom. Stabilizers, set and released from the operator's seat, provide four-point support for heavy loads. Powered by a Caterpillar 4x$5\frac{1}{2}$ engine. The crane is known as "Loadmaster." Bucyrus-Erie Co., South Milwaukee, Wis.

■

Switches

Improvements that include larger boxes, positive quick-make and quick-break mechanism, and positive-pressure

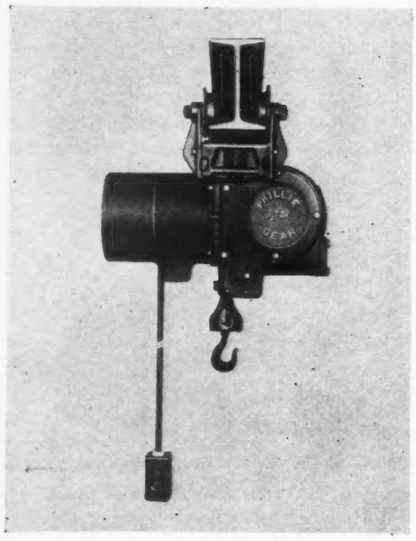
fuse clips, make the Type C switches equivalent to the Type A, except for keyed interlocking. Capacities: 30 to 600 amp., 250 volts, and 30 to 200 amp., 575 volts, fused or unfused.

Also announced is a new general service line of industrial safety switches in capacities from 30 to 400 amp., 250 and 575 volts, fused or unfused. Above 30 amp., quick break only. Square D Co., Detroit, Mich.

■

Electric Hoist

Sizes from ¼ to 3-ton. Designed for high lift with low head room. The hoist swivel trolleys turn on a 4-ft. radius. Oil-bath lubrication is provided, and the



operating mechanism is sealed against leakage. Control is by pushbutton; no load brake is necessary. Ball or roller bearings are used at points of maximum service demand. Philadelphia Gear Works, Philadelphia, Pa.

■

Precision Bench Lathe

Back-geared, screw-cutting type, 8-in., 9-in., or 11-in. swing sizes. Cuts all standard screw threads, right and left hand, from 2 to 90 per inch.

Features: six spindle speeds; drum-type reversing switch; graduated tailstock spindle; automatic feeds; precision lead screw. Driven by belt from reversing motor mounted under the bench, beneath headstock. South Bend Lathe Works, South Bend, Ind.

■

Rubber Transmission Belting

Named "Highflex Junior." Built of specially woven fabric, designed to be spliced endless on the machine. Made only in widths 6 in. and under.

Automatically controlled, portable electric vulcanizers have been developed by James C. Heintz Co., Cleveland, Ohio, for joining these belts. The B. F. Goodrich Co., Akron, Ohio.

■

Explosion-Resisting Linestarters

For use in Class I, Group D, hazardous locations—Article 32, National Electrical Code—where highly flammable volatile liquids or gases are present.

Consist of standard linestarter units with De-ion contactor, combination hand and automatic reset thermal overload relay in heavy, cast-iron cabinets having wide flanges in accordance with Underwriters' specifications. Separate-mounted or built-in pushbuttons. Explosion-resisting pushbuttons available for two-wire and three-wire control. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

■

Portable Electric Hand Saw

"Skilsaw," Model W. For light duty, ⅓-hp. universal motor, 6-in. saw blade, 1⅞-in. depth of cut, die-cast aluminum frame, weight 8 lb., ball bearings. Base adjustable for depth of cut; has apron type safety guard. Momentary safety switch. Skilsaw, Inc., Chicago, Ill.

■

Mechanical-Drive Turbine

Non-condensing steam turbine for driving centrifugal pumps, fans, other rotating equipment. Speeds 1,200 to 4,000 r.p.m., available up to 250-hp. rating. Single stage, two rows of revolving buckets. Wheel casing split horizontally to allow access to internal parts; all pipes connected to lower half. Centrifugal governor for speed regulation. Independent emergency governor included. Designated type D-59. General Electric Co., Schenectady, N. Y.

■

Ball Bearing

Known as Type "CD" Duplex double angular contact. Designed to carry both radial and high thrust loads in either direction, but with width no greater than that of a standard single-row bearing.

Outer ring is made in two parts, and both inner and outer raceways are ground to a curvature suitable for carrying heavy end thrust. A one-piece ball retainer rides upon the ground flanges of the inner ring.

Available in light, medium, and heavy metric series from 10- to 100-mm. bore. According to the manufacturer they should be used only where the thrust load exceeds the radial load, and the duplex outer ring should be clamped tight in the housing. Norma-Hoffman Bearings Corp., Stamford, Conn.

■

Liquid Meters

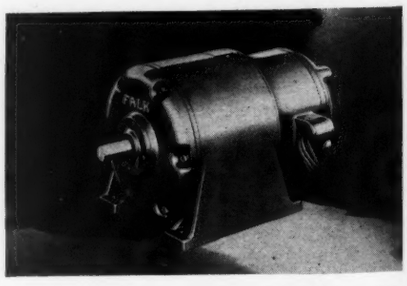
Disk, current or turbine, compound and piston meters for measuring liquids. Available as the result of an arrangement made for the joint use of the manufacturing, sales, and service facilities of the Meter Division of the Worthington Pump and Machinery Corp., Harrison, N. J., and the Gamon Meter Co., 282 South St., Newark, N. J.

■

Combined Motor and Speed Reducer

Known as "Motoreducer," and offered in three types. In each type the gear housing acts as a support for the motor. In the "Integral" type the motor end bell is removed and the motor is close-coupled through a bayonet type joint to the gear case. In the "Flexible" type the round frame type motor is used and the end bell is retained. In the "All-Motor" type any standard horizontal type motor may be used, the motor being connected through a Falk flexible coupling to the reducer housing.

All types are supplied in horsepowers from ¾ to 75, with ratios from 4.6 to 288. Non-planetary, helical-type gears are used

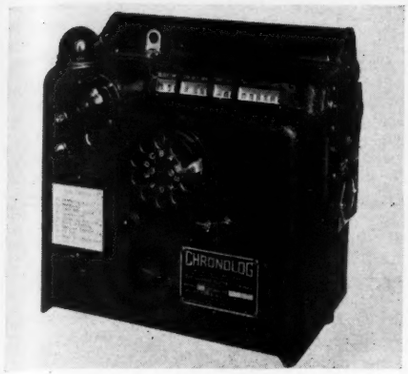


in all but the larger sizes. Illustrated is the "Integral" type. The Falk Corporation, Milwaukee, Wis.

■

Machine Performance Recorder

Called Chronolog. Records machine time on paper roll. Operator dials variations in operation. Code letters used to indicate all operations on or causes of interruptions to production. Thus, P stands for production; E, down for stock; J, stop for inspection, etc.



Daily record then shows cause for idle time, accumulated idle time, accumulated production time; total pieces produced; time consumed by inspector, maintenance man, etc. Developed by National Acme Co., Cleveland, Ohio; distributed by Graybar Electric Co., New York, N. Y.

■

Water- and Dust-Tight Starter

Across-the-line a.c. starter, motor control switch, test jack. Thermal overload and low-voltage protection are provided. Inclosed in cast-iron cabinet having machined flanges and fitted with rubber gaskets to exclude moisture and dust, but is not explosion-proof. Built in two sizes, Class 8532S and 8536S, fusible or non-fusible. Industrial Controller Division, Square D Co., Milwaukee, Wis.

■

Split-Phase Motors

End brackets are cast iron, designed to protect from falling objects, dust, or dripping water. Frames of rolled steel construction.

Thick-walled bearings machined from phosphor-bronze castings. Wool yarn system of lubrication is said to assure at least one year's operation 24 hours a day without reoiling. Ratings from 1/60 to 1/3 horsepower. Century Electric Co., St. Louis, Mo.

■

Motor Reducer

Called "MotoReduceR" by the manufacturer. Motor and gear apparatus are contained in a single housing with supporting feet at the ends of the frame. The reducer has helical gears running in an oil bath, and anti-friction bearings. Slow-speed shaft mounting is designed to permit overhang of pinion, sprocket, or pulley, without outboard bearing. Available in single, double, and triple types, ratios up to 450:1, with open or inclosed motors, polyphase and single phase. Also with d.c. motors up to 10 hp. Philadelphia Gear Works, Philadelphia, Pa.

Bearings

Made from a textile material impregnated with synthetic resin. Known as "Ryertex." The makers characterize the bearings as resistant to most acids, and non-absorbent as to oil and water, and state that they cannot be softened by heat, but are attacked by hot caustic alkalies. Brinell 30-40, scleroscope 70-80. The bearings are molded to finished size, under pressure and heat. Can be used with either water or oil as lubricant. Joseph T. Ryerson & Son, Inc., 16th & Rockwell Sts., Chicago,

■

Rubber Paints

Base is a commercial form of rubber isomer, claimed by the manufacturer to impart exceptional properties, including adhesion when applied to a properly prepared surface; one-hour drying, with retention of the elastic properties of rubber to a great extent; retention of chemically resistant properties of rubber, providing great resistance to corrosive action of acids, alkalies, and chemical fumes; non-absorption of water. The B. F. Goodrich Rubber Co., Akron, Ohio.

■

Fractional-Horsepower Motors

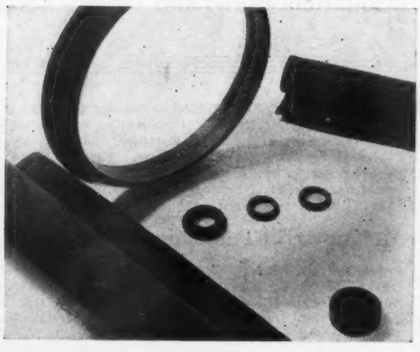
Include a new type of capacitor motor; all other types of small a.c. and d.c. motors have been redesigned. Frames, shafts, bearings, mounting arrangements are interchangeable, rating for rating. Five frame sizes serve the entire line, ranging from 1/30 to ¾ hp.

Featured is a resilient spring mounting that nullifies vibration. Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

■

"Thiokol" Packings

Diaphragms, disks, gaskets and other packings made of Thiokol compounds. This material, a chemical product (*M.E.*, July, 1932) is said to have most of the characteristics of rubber but not to be affected by the same solvents. Recommended by the manufacturer for use with or near gasoline, ether, kerosene, carbon tetra-chloride, and gas. Garlock Packing Co., Palmyra, N. Y.



■

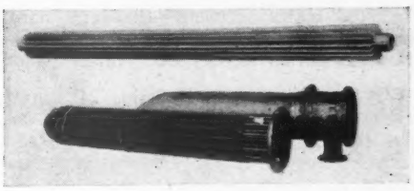
Humidity Control

A device designed to put into or out of operation humidifying or dehumidifying equipment. Said by the makers to operate within a range of plus or minus three per cent of setting. A hygroscopic, ribbon type element, not affected by dry bulb temperature, expands or contracts as the moisture content of the air varies. This motion is multiplied by a lever mechanism and is used to operate a mercury tube switch connected to the humidification or dehumidification equipment. Overall dimensions: Width, 2⅞ in.; length, 7⅞ in.; depth, 1¾ in. Lewis Air Conditioners, Inc., 829 Second Ave., South, Minneapolis, Minn.

■

Storage Tank Oil Heater

Heating elements are composed of a number of U-shaped steel pipes having longitudinal fins along the exterior surface of the straight portions of each pipe. Fins are equally spaced about the circumference of the pipe, and are fastened by a mechanical process. The heater is installed with shell and heating elements extending into the tank and



steam, drain, and oil connections outside. The Griscom-Russell Company, 285 Madison Avenue, New York, N. Y.

■

Arc Welder

Driven by 42-hp., 1,750 r.p.m. Waukesha gasoline engine. Rated 300 amp. Available in stationary and portable types.

Generator equipped with panelboard containing flush-type voltmeter, ammeter, cable terminal studs. One control regulates welding current, 40 and 25 volts. Auxiliary generator can be furnished to operate lights and tools.

Portable welder completely inclosed, mounted on arc-welded steel base, with spring suspension, wire wheels, pneumatic tires. Harnischfeger Corp., Milwaukee, Wis.

TRADE LITERATURE

For copies, address the manufacturers concerned

■

(262) ARC WELDING—Booklet, 32 pages, "The Many Profitable Uses of 'Simplified' Arc Welding."—Hobart Brothers Co., Troy, Ohio.

(263) SPEED REDUCERS—Bulletin 260, announcement of Falk "Motoreducers"—combination of standard motors and Falk speed reducers.—The Falk Corp., Milwaukee, Wis.

(264) MATERIALS HANDLING — Folder 4 pages; push-button controlled electric hoist, ¼ to 3-ton capacity.—Philadelphia Gear Works, Erie Ave. & G St., Philadelphia, Pa.

(265) GAS-ELECTRIC SETS—Publication C-1959, 8 pages. Gas-electric sets.—Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

(266) PUMPS—Catalog B-5, 24 pages. Single suction, multistage centrifugal pumps.—De Laval Steam Turbine Co., Trenton, N. J.

(267) OIL HEATER—Form 484. The G-R storage tank oil heater.—The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.

(268) SPEED REDUCERS—Catalog 302, "Hygrade" worm gear speed reducers.—Foote Brothers Gear & Machine Co., 215 N. Curtis St., Chicago, Ill.

(269) GAS TRUCKS—Booklet, illustrations of the various sizes and models of Clark Tructractors.—Clark Tructractor Co., Battle Creek, Mich.

(270) HARD RUBBER—Booklet, hard rubber in sheet, rod and tubing form.—B. F. Goodrich Rubber Co., Akron, Ohio.

(271) CONVEYORS—Bulletin, 24 pages. Design and operating principles of the Redler "En Masse" conveyor.—The Redler Conveyor Co., 117 Liberty St., New York, N. Y.

(272) ARC WELDING—Bulletin, 8 pages, "The New Lincoln 'Shield-Arc' Welder."—The Lincoln Electric Co., Cleveland, Ohio.

(273) LINE MATERIALS—Catalog 234, 100 pages, "Westinghouse Trolley Line Material and Rail Bonds."—Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

(274) TIMESTARTERS — Leaflet 20554, heavy duty timestarters for positive starting and protection of constant speed d.c. motors in mill and mine service.—Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

(275) WELDING — Booklet "Repairing for Profit," 17 pages, two articles: "Oxy-Acetylene Welding in Automotive Repair" and "Selling Auto Repairs Does Pay."—The Linde Air Products Co., 205 E. 42nd St., New York, N. Y.

(276) LIGHTNING ARRESTERS—Booklet No. 8 of a series on Crystal Valve Lightning Arresters, "High Speed."—Electric Service Supplies Co., 17th and Cambria Sts., Philadelphia, Pa.

(277) REFRIGERATION—1932 edition of "Artic—The Refrigerant." Properties and uses of this refrigerant—new thermodynamic and other technical data for users or specifiers of refrigerants.—The Roessler & Hasslacher Chemical Co., Inc., Empire State Bldg., New York, N. Y.

(278) LIFTING MAGNETS—Bulletin 900, 16 pages.—The Electric Controller & Mfg. Co., Cleveland, Ohio.

(279) ELECTRIC HEATING APPLIANCES—Catalog D, industrial and commercial electric heating equipment.—Acme Electric Heating Co., 1217 Washington St., Boston, Mass.

(280) TERMINATORS—Bulletin 65-AC, vacuum type single and multiple conductor terminators for indoor service. Delta-Star Electric Co., 2400 Block, Fulton St., Chicago, Ill.

(281) MOTORS — Folder GEA - 1628, squirrel-cage motors.—General Electric Co., Schenectady, N. Y.

(282) LUBRICATION—Technical Bulletin Number 200.2, "The Mechanics of Lubrication with Collodial Graphite."—Acheson Oildag Co., Port Huron, Mich.

(283) SPEED REDUCERS — Catalog No. 27, 44 pages, "Speed Reducers and Transmission Machinery."—Winfield H. Smith, Inc., Springville, Erie Co., N. Y.

(284) ALUMINUM—Supplement to the Structural Aluminum Handbook, contains additions to the tables and new data which were not available at the time the handbook was published.—Aluminum Co. of America, Pittsburgh, Pa.

(285) BEARINGS—Folder, "Micarta Roll Neck Bearings," operating and construction details.—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

(286) PUMPS—Catalog B-4, 16 pages, single stage, double suction, centrifugal pumps.—De Laval Steam Turbine Co., Trenton, N. J.

(287) HEATING UNITS—Leaflet TB-30, electric immersion units.—Harold E. Trent Co., 618-640 No. 54th St., Philadelphia, Pa.

(288) ELECTRIC LOCOMOTIVES—Publication D.M.F. 5449, 4 pages, diesel electric locomotives in the steel industry.—Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.

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